

Test Report No:  
75462RRF.004

## Test Report

### USA FCC Part 90 CANADA RSS-140

(*) Identification of item tested	LTE Cat-4
(*) Trademark	Sequans Communications
(*) Model and /or type reference	CA410
Other identification of the product	FCC ID: 2AAGMCA410A IC: 12732A-CA410A
(*) Features	LTE Cat-4 HW version: V1 SW version: LR4.1.6.0-CBRSA-59334
Applicant	SEQUANS COMMUNICATIONS 55 Boulevard Charles de Gaulle, 92700 Colombes, France
Test method requested, standard	USA FCC Part 90 (10-1-21 Edition). CANADA RSS-140 Issue 1, April 2018 ANSI C63.26-2015. KDB 971168 D01 Power Meas License Digital Systems v03r01, April. 2018.
Summary	IN COMPLIANCE
Approved by (name / position & signature)	José Manuel Gómez Galván EMC Consumer & RF Lab. Manager
Date of issue	2023-10-17
Report template No	FDT08_24 (*) "Data provided by the client"

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## Competences and guarantees

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In order to assure the traceability to other national and international laboratories, DEKRA Testing and Certification has a calibration and maintenance program for its measurement equipment.

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## General conditions

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1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of DEKRA Testing and Certification S.A.U.
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## Uncertainty

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Uncertainty (factor  $k=2$ ) was calculated according to the DEKRA Testing and Certification S.A.U. internal document PODT000.

## Data provided by the client

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The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested").
2. The sample model CA410 is ideal for adding LTE connectivity to electronics devices for industrial Internet of Things (IoT), Machine-to-Machine (M2M) and broadband consumer applications. CA410 is compliant with CBRS networks operating on LTE band 48 in USA, with US B8 – known as Anterix band - and with other US MNO bands: bands 2/4/5/12/13/66 as well as Firstnet LTE band 14 and band 26 used in private networks.

DEKRA Testing and Certification S.A.U. declines any responsibility with respect to the information provided by the client and that may affect the validity of results.

## Usage of samples

Samples undergoing test have been selected by: The client.

- Sample S/01 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
75462C/ 015 *	LTE Cat-4	CA410- EVK	FOX-23-26-0660	25-07-2023
76162C/001 **	Testing Box	CA410- EVK	FOX-23-34-0682	11-09-2023
75462C/017	USB Cable	-	-	25-07-2023
75462C/022 ***	LTE Cat-4	CA410- EVK	FOX-23-26-0647	20-09-2023

Sample S/01 has undergone the following test(s): The conducted tests indicated in Appendix A.

- \* : EUT used in all the conducted tests for the LTE Cat-4 Band 14 but the PAPR test.
- \*\* : EUT used in all the conducted tests for the LTE Cat-4 Band 26 but the Mask EA test.
- \*\*\* : EUT used in the PAPR test for the LTE Cat-4 Band 14 and the Mask EA test for the LTE Cat-4 Band 26.

- Sample S/02 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
76162C/001	Testing Box	CA410- EVK	FOX-23-34-0682	11-09-2023
76162C/002	Testing Box	CA410- EVK	FOX-23-34-0683	11-09-2023
75462C/003	Antenna	-	-	-
75462C/004	Antenna	-	-	25-07-2023

Sample S/02 has undergone the following test(s): The radiated tests indicated in Appendix A.

## Test sample description

Ports.....:	Port name and description	Cable				
		Specified max length [m]	Attached during test	Shielded	Coupled to patient <sup>(3)</sup>	
	USB	-	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Supplementary information to the ports.....:	-					
Rated power supply .....	Voltage and Frequency		Reference poles			
			L1	L2	L3	N
	<input type="checkbox"/>	AC:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input checked="" type="checkbox"/>	DC: 3.2V Min, 3.3V Typ, 4.6V Max				
Rated Power..... :	-					
Clock frequencies..... :	-					
Other parameters .....	-					
Software version..... :	-					

Hardware version .....	-		
Dimensions in cm (W x H x D) ...	-		
Mounting position .....	<input checked="" type="checkbox"/>	Table top equipment	
	<input type="checkbox"/>	Wall/Ceiling mounted equipment	
	<input type="checkbox"/>	Floor standing equipment	
	<input type="checkbox"/>	Hand-held equipment	
	<input type="checkbox"/>	Other:	
Modules/parts.....	<b>Module/parts of test item</b>	<b>Type</b>	<b>Manufacturer</b>
	-	-	-
Accessories (not part of the test item) .....	<b>Description</b>	<b>Type</b>	<b>Manufacturer</b>
	USB Cable	USB	-
	Antenna	Antenna	-
Documents as provided by the applicant .....	<b>Description</b>	<b>File name</b>	<b>Issue date</b>
	-	-	-

<sup>(3)</sup> Only for Medical Equipment

## Identification of the client

SEQUANS COMMUNICATIONS  
 55 Boulevard Charles de Gaulle, 92700, Colombes, France

## Testing period and place

<b>Test Location</b>	DEKRA Testing and Certification S.A.U.
<b>Date (start)</b>	2023-08-02
<b>Date (finish)</b>	2023-09-21

## Document history

Report number	Date	Description
75462RRF.004	2023-10-17	First release.

## Environmental conditions

In the control chamber, the following limits were not exceeded during the test:

<b>Temperature</b>	Min. = 15 °C Max. = 35 °C
<b>Relative humidity</b>	Min. = 20 % Max. = 75 %

In the semi-anechoic chamber, the following limits were not exceeded during the test:

<b>Temperature</b>	Min. = 15 °C Max. = 35 °C
<b>Relative humidity</b>	Min. = 20 % Max. = 75 %

In the chamber for conducted measurements, the following limits were not exceeded during the test:

<b>Temperature</b>	Min. = 15 °C Max. = 35 °C
<b>Relative humidity</b>	Min. = 20 % Max. = 75 %

## Remarks and comments

The tests have been performed by the technical personnel: Rafael Fernández, Sergio Carrasco, Valentín Andarias, Carmen Vázquez, Ireneo Bibang, Fernando Chito, Francisco López, Antonio Maireles.

Used instrumentation:

Control No.	Equipment	Model	Manufacturer	Next Calibration
6794	Shielded Room	S101	ETS LINDGREN	N/A
9229	Wideband Radio Communication Tester	CMW500	ROHDE AND SCHWARZ	2024-06
6157	Signal and Spectrum Analyzer 10 Hz - 40 GHz	FSV40	ROHDE AND SCHWARZ	2023-10
8002	TEMPERATURE CHAMBER MK56 BINDER	MK 56	BINDER	2024-04
6791	SEMIANECHOIC ABSORBER LINED	FACT 3 200 STP	ETS LINDGREN	N/A
6792	SHIELDED ROOM	S101	ETS LINDGREN	N/A
6143	Biconical/Log Antenna 30 MHz - 6 GHz	3142E	ETS LINDGREN	2023-10
4612	HORN ANTENNA 1-18GHz	BBHA 9120 D	SCHWARZBECK	2024-07
7817	EMI TEST RECEIVER 2Hz-44GHz	ESW44	ROHDE AND SCHWARZ	2023-12
3783	PRE-AMPLIFIER G>30dB 1GHz-18GHz	BLMA 0118-3A	BONN ELEKTRONIK	2023-12
6144	RF Preamplifier 40 dB, 10 MHz - 6 GHz	BLNA 0160-01N	BONN ELEKTRONIK	2024-07
6667	Wideband Radio Communication Tester	CMW500	ROHDE AND SCHWARZ	2024-06
7760	Digital Multimeter	175	FLUKE	2023-11
7798	EMC/RF MEASUREMENT SOFTWARE	WMS32	ROHDE AND SCHWARZ	N/A
4848	SOFTWARE FOR EMC/RF TESTING	EMC32	ROHDE AND SCHWARZ	N/A

## Testing verdicts

Not applicable:	N/A
Pass:	P
Fail:	F
Not measured:	N/M

## Summary

### LTE Cat-4 Band 14.

FCC PART 90 / RSS-140 PARAGRAPH		
Requirement – Test case	Verdict	Remark
FCC 90.542 (a) (7) / RSS-140 Clause 4.3: Transmitter output power: RF output power	P	
FCC 2.1047 / RSS-140 Clause 4.1: Modulation characteristics	P	
FCC 90.213 / RSS-140 Clause 4.2: Frequency stability	P	
FCC 2.1049 / RSS-Gen Clause 6.7: Occupied bandwidth (or 99% emission bandwidth)	P	
FCC 90.691 / RSS-140 Clause 4.4: Spurious emissions at antenna terminals	P	
FCC 90.691 / RSS-140 Clause 4.4: Spurious emissions at antenna terminals (Emission mask requirements for EA-based systems)	P	
FCC 90.691 / RSS-140 Clause 4.4: Radiated emissions	P	
<u>Supplementary information and remarks:</u> None.		

### LTE Cat-4 Band 26.

FCC PART 90 PARAGRAPH		
Requirement – Test case	Verdict	Remark
FCC 90.635 (b): Transmitter output power: RF output power	P	
FCC 2.1047: Modulation characteristics	P	
FCC 90.213: Frequency stability	P	
FCC 2.1049: Occupied bandwidth (or 99% emission bandwidth)	P	
FCC 90.691: Spurious emissions at antenna terminals	P	
FCC 90.691: Spurious emissions at antenna terminals (Emission mask requirements for EA-based systems)	P	
FCC 90.691: Radiated emissions	P	
<u>Supplementary information and remarks:</u> None.		

## Appendix A:

Test results for FCC 90 / RSS-140: LTE Cat-4  
Band 14, and for FCC 90: LTE Cat-4 Band 26



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## TEST CONDITIONS

(\*): Declared by the Applicant.

### POWER SUPPLY (\*):

Vnominal: 3.2 Vdc  
 Vminimum: 3.3 Vdc  
 Vmaximum: 4.6 Vdc

Type of Power Supply: DC External.

### ANTENNA (\*):

LOW Bands	GAIN	ANTENNA TYPE
LTE Cat-4 Band 14	-1.1 dBi	External (reference 2JW1183-C952B)
LTE Cat-4 Band 26	-1.1 dBi	External (reference 2JW1183-C952B)

### TEST FREQUENCIES:

LTE Band 14. QPSK and 16QAM:

	Channel (Frequency, MHz)	
	BW=5 MHz	BW=10 MHz
Low	23305 (790.5)	N/A
Middle	N/A	23330 (793)
High	23355 (795.5)	N/A

LTE Cat-4 Band 26. Sub-band 814-824 MHz. QPSK and 16QAM:

	Channel (Frequency, MHz)				
	BW=1.4 MHz	BW=3 MHz	BW=5 MHz	BW=10 MHz	BW=15 MHz
Low	26697 (814.7)	26705 (815.5)	26715 (816.5)	N/A	N/A
Middle	26740 (819)	26740 (819)	26740 (819)	26740 (819)	N/A
High	26783 (823.3)	26775 (822.5)	26765 (821.5)	N/A	N/A

LTE Cat-4 Band 26. Cross-rule Channel (824 MHz). QPSK and 16QAM:

Channel (Frequency, MHz)				
BW=1.4 MHz	BW=3 MHz	BW=5 MHz	BW=10 MHz	BW=15 MHz
26790 (824)	26790 (824)	26790 (824)	26790 (824)	26790 (824)



## RF Output Power

### Limits

#### 1. LTE Cat-4 Band 14:

\* FCC § 90.542 (a) (7):

(a) The following power limits apply to the 763-768 / 793-798 MHz band:

(7) Portable stations (hand-held devices) transmitting in the 763-768 MHz band and the 793-798 MHz band are limited to 3 watts ERP.

\* RSS-140 Clause 4.3: The equivalent radiated power (e.r.p.) for control and mobile equipment shall not exceed 30 W. The e.r.p. for portable equipment including handheld devices shall not exceed 3 W.

Fixed and base station equipment shall comply with the e.r.p. limits in SRSP-540.

In addition, the peak to average power ratio (PAPR) of the equipment shall not exceed 13 dB for more than 0.1% of the time, using a signal that corresponds to the highest PAPR during periods of continuous transmission.

#### 2. LTE Cat-4 Band 26:

\* FCC § 90.635 (b): The maximum output power of the transmitter for mobile stations is 100 Watts (20 dBW).

### Method

The conducted RF output power measurements were made at the RF output terminals of the EUT using the power meter of the Universal Radio Communication tester R&S CMW500, selecting maximum transmission power of the EUT and different modes of modulation.

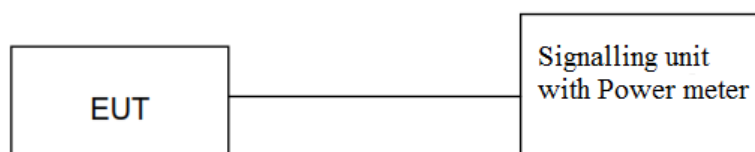
The maximum equivalent isotropically radiated power (e.i.r.p.) is calculated by adding the declared maximum antenna gain (dBi).

The maximum effective radiated power e.r.p. is calculated from the maximum equivalent isotropically radiated power (e.i.r.p.) by subtracting 2.15 dB:

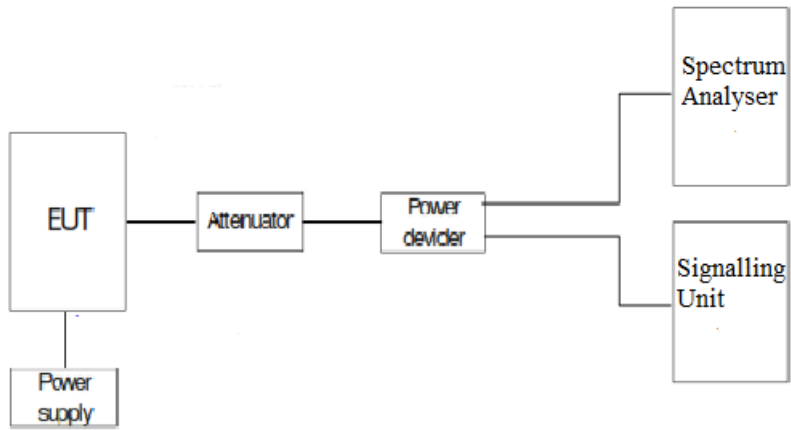
$$\text{E.R.P.} = \text{E.I.R.P.} - 2.15 \text{ dB}$$

### Test Setup

#### 1. CONDUCTED AVERAGE POWER:



2. PEAK-TO-AVERAGE POWER RATIO (PAPR):



**Results**

**1. CONDUCTED AVERAGE POWER:**

Measurements required on one frequency near top channel and one frequency near bottom channel, according to FCC § 15.31 (m).

LTE Cat-4 Band 14:

Worst case of RF Power is BW=5 MHz, Low Channel, QPSK, RB Size=1, RB Offset=24.

BANDWIDTH (MHz)	CHANNEL	FREQUENCY (MHz)	MODULATION	RB SIZE	RB OFFSET	AVERAGE POWER (dBm)
5	Low 23305	790.5	QPSK	1	0	23.8
				1	12	23.84
				1	24	23.9
				12	0	22.72
				12	6	22.65
				12	11	22.43
			25	0	22.67	
			16-QAM	1	0	22.95
				1	12	22.87
				1	24	22.93
				12	0	21.71
				12	6	21.68
	12	11		21.53		
	High 23355	795.5	QPSK	1	0	23.82
				1	12	23.02
				1	24	22.74
				12	0	22.64
				12	6	22.21
				12	11	21.93
			25	0	22.25	
			16-QAM	1	0	22.89
				1	12	22.13
				1	24	21.81
				12	0	21.68
12				6	21.27	
12	11	20.99				
25	0	21.33				

BW=5 MHz. QPSK:

MAX POWER	QPSK COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG ERP(dBm)
LOW	23.9	-1.1	20.65
HIGH	23.82	-1.1	20.57
MAX:	23.9	-1.1	20.65

BW=5 MHz. 16QAM:

MAX POWER	16QAM COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG ERP(dBm)
LOW	22.95	-1.1	19.7
HIGH	22.89	-1.1	19.64
MAX:	22.95	-1.1	19.7

LTE Cat-4 Band 26. Sub-band 814-824 MHz:

Worst case of RF Power is BW=5 MHz, Low Channel, 16QAM, RB Size=1, RB Offset=24.

BANDWIDTH (MHz)	CHANNEL	FREQUENCY (MHz)	MODULATION	RB SIZE	RB OFFSET	AVERAGE POWER (dBm)
5	Low 26715	816.5	QPSK	1	0	22.73
				1	12	22.57
				1	24	22.9
				12	0	21.57
				12	6	21.49
				12	11	21.52
			25	0	21.62	
			16-QAM	1	0	21.79
				1	12	21.53
				1	24	21.93
				12	0	20.56
				12	6	20.6
	12	11		20.64		
	High 26765	821.5	QPSK	25	0	20.65
				1	0	22.85
				1	12	22.61
				1	24	22.72
				12	0	21.73
				12	6	21.58
			12	11	21.8	
			25	0	21.6	
			16-QAM	1	0	22.09
				1	12	21.86
				1	24	21.77
12				0	20.8	
12	6	20.62				
12	11	20.81				
25	0	20.61				



BW=5 MHz. QPSK:

MAX POWER	QPSK COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG ERP(dBm)
LOW	22.9	-1.1	19.65
HIGH	22.85	-1.1	19.6
MAX:	22.9		19.65

BW=5 MHz. 16QAM:

MAX POWER	QPSK COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG ERP(dBm)
LOW	21.93	-1.1	18.68
HIGH	22.09	-1.1	18.84
MAX:	22.09		18.84

LTE Cat-4 Band 26. Cross-rule Channel 824 MHz:

Worst case of RF Power is BW=15 MHz, Middle Channel, QPSK, RB Size=1, RB Offset=37.

BANDWIDTH (MHz)	CHANNEL	FREQUENCY (MHz)	MODULATION	RB SIZE	RB OFFSET	AVERAGE POWER (dBm)
15	Single 26790	824	QPSK	1	0	22.68
				1	37	22.88
				1	74	22.63
				36	0	21.5
				36	18	21.64
				36	37	21.45
				75	0	21.39
			16-QAM	1	0	21.95
				1	37	22.22
				1	74	22
				36	0	20.52
				36	18	20.73
				36	37	20.44
				75	0	20.46

BW=10 MHz. QPSK:

MAX POWER	QPSK COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG ERP(dBm)
SINGLE	22.88	-1.1	19.63
MAX:	22.88		19.63

BW=10 MHz. 16QAM:

MAX POWER	16QAM COND. POWER AVG (dBm)	ANTENNA GAIN (dBi)	RAD. POWER AVG ERP(dBm)
SINGLE	22.22	-1.1	18.97
MAX:	22.22		18.97

Measurement uncertainty (dB)  $\leq \pm 1.11$

**Verdict**

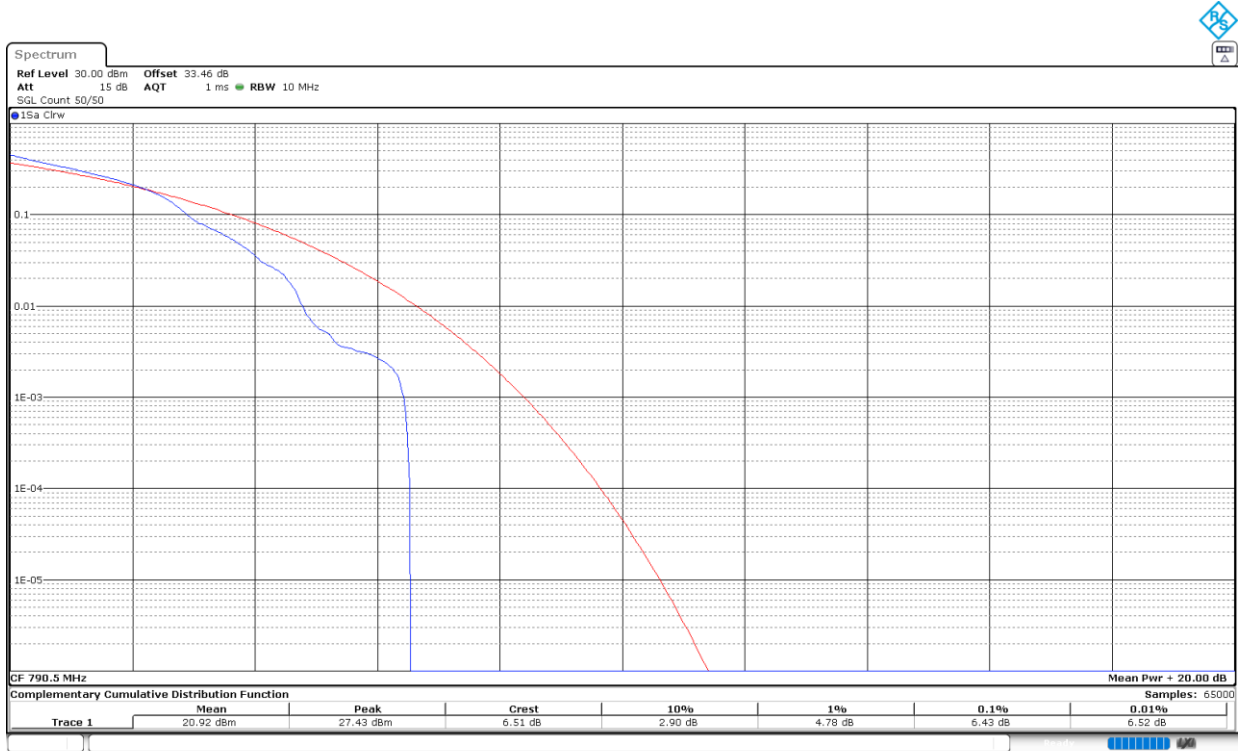
Pass

## 2. PEAK-TO-AVERAGE POWER RATIO (PAPR):

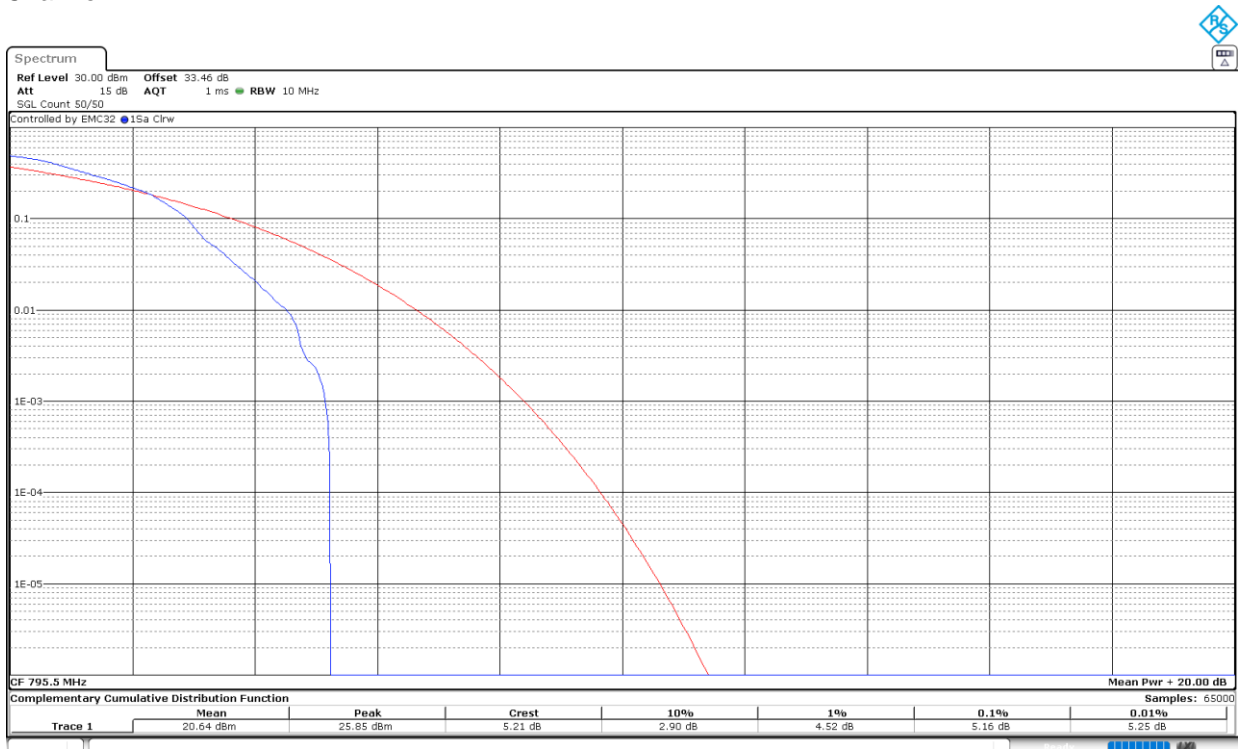
LTE Cat-4 Band 14:

Preliminary measurements determined the worst case of PAPR is BW=5 MHz, Low Channel, 16QAM, RB Size=1, RB Offset=0.

Low Channel:



High Channel:



16QAM	Low	High
PAPR (dB)	6.43	5.16

Measurement uncertainty (dB)  $<\pm 1.11$

**Verdict**

Pass

## Frequency Stability

### Limits

#### 1. LTE Cat-4 Band 14:

\* FCC § 2.1055:

- (a) The frequency stability shall be measured with variation of ambient temperature as follows:
  - (1) From  $-30^{\circ}$  to  $+50^{\circ}$  centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.
- (b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than  $10^{\circ}$  centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.
- (c) The frequency stability shall be measured with variation of primary supply voltage as follows:
  - (1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.
  - (2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.
  - (3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

\* RSS-140 Clause 4.2:

The frequency stability shall be sufficient to ensure that the occupied bandwidth stays within the operating frequency block when tested at the temperature and supply voltage variations specified in RSS-Gen.

#### 2. LTE Cat-4 Band 26:

\* FCC § 2.1055:

- (a) The frequency stability shall be measured with variation of ambient temperature as follows:
  - (1) From  $-30^{\circ}$  to  $+50^{\circ}$  centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.
- (b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than  $10^{\circ}$  centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.
- (c) The frequency stability shall be measured with variation of primary supply voltage as follows:

- (1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.
- (2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.
- (3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

\* FCC § 90.213:

(a) Unless noted elsewhere, transmitters used in the services governed by this part must have a minimum frequency stability as specified in the following table.

MINIMUM FREQUENCY STABILITY [Parts per million (ppm)]		
Frequency range (MHz)	Mobile stations	
	Over 2 watts output power	2 watts or less output power
809-824	2.5	2.5

(b) For the purpose of determining the frequency stability limits, the power of a transmitter is considered to be the maximum rated output power as specified by the manufacturer.

### Method

The frequency tolerance measurements over temperature variations were made over the temperature range of -30°C to +50°C. The EUT was placed inside a climatic chamber and the temperature was raised hourly in 10°C steps from -30°C up to +50°C.

The supply voltage was varied between 85% and 115% of nominal voltage.

The EUT was set in “Radio Resource Control (RRC) mode” in the middle channel using the Universal Radio Communication tester R&S CMW500 and the maximum frequency error was measured using the built-in calibrated frequency meter.

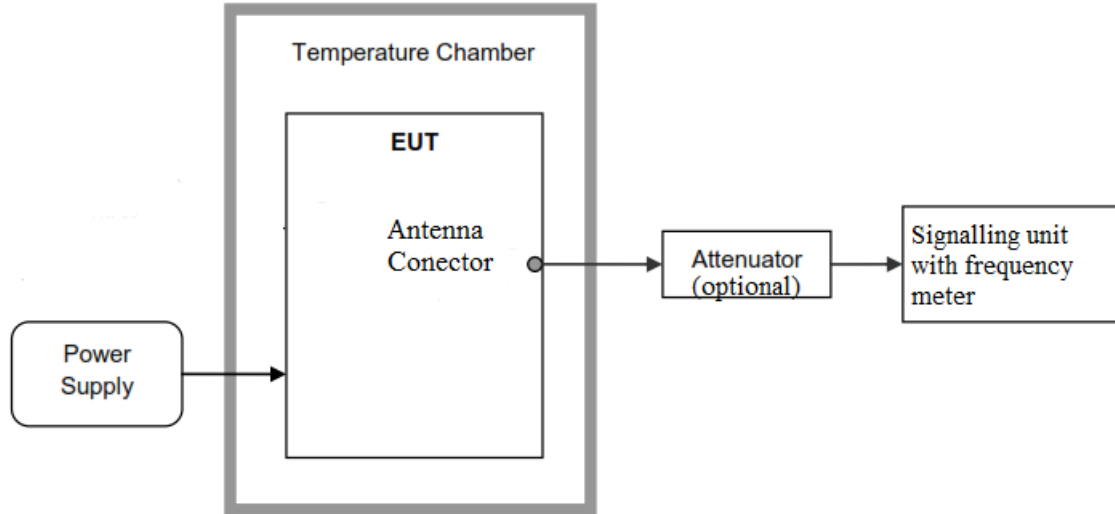
The worst case LTE mode for conducted power was used for the test.

In order to check that the frequency stability is sufficient such that the fundamental emissions stay within the authorized bands of operation, a reference point is established at the applicable unwanted emissions limit using a RBW equal to the RBW required by the unwanted emissions specification of the applicable regulatory standard. These reference points measured using the Low and High channel of operation are identified as fL and fH respectively. The worst case frequency offset determined in the above methods is added or subtracted from the values of fL and fH to check that the resulting frequencies remain within the band.

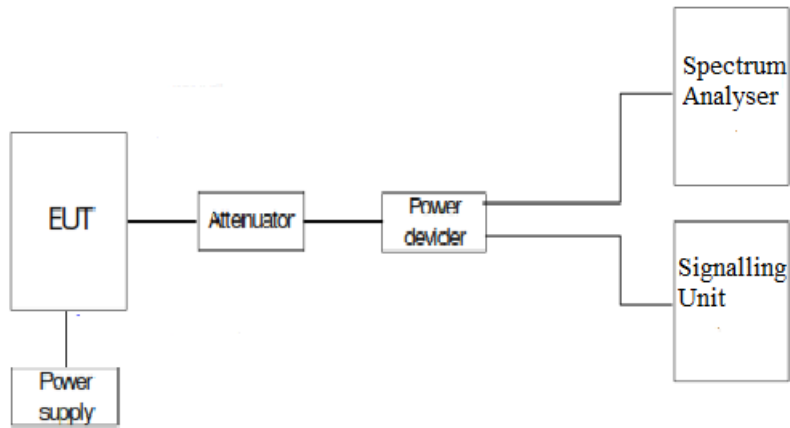
The reference point measurements were made at the RF output terminals of the EUT using an attenuator, power splitter and spectrum analyser. The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation.

### Test Setup

#### 1. Frequency Tolerance:



#### 2. Reference Frequency Points $f_L$ and $f_H$ :



**Results**

**LTE Cat-4 Band 14:**

The worst case modulation in terms of Frequency Stability is BW=10 MHz, QPSK, RB Size=1, RB Offset=0.

**1. Frequency Tolerance:**

- **Frequency Stability over Temperature Variations:**

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
+65	-5,47	-0,006897856
+60	7,3	0,009205549
+50	0.69	0.000870113
+40	-0.44	-0.000554855
+30	-0.64	-0.000807062
+20	-0.93	-0.001172762
+10	0.31	0.000390921
0	1.16	0.001462799
-10	1.79	0.002257251
-20	2.06	0.00259773
-30	4.03	0.005081967
-40	-2,1	-0,002648172

- **Frequency Stability over Voltage Variations.**

Battery Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
Vmax	4.6	2,17	0,002736444
Vmin	3.2	5,06	0,006380832

**2. Reference Frequency Points fL and fH:**

The worst case frequency offsets added or subtracted per band and bandwidth:

fL (MHz)	788.0591
fH (MHz)	797.9115

The reference frequency points fL and fH stay within the authorized blocks for all the band above.

Measurement uncertainty (Hz)  $\leq \pm 249.55$

**Results**

PASS



**LTE Cat-4 Band 26. Sub-band 814-824 MHz:**

The worst case modulation in terms of Frequency Stability is BW=10 MHz, QPSK.

**1. Frequency Tolerance:**

- Frequency Stability over Temperature Variations:**

Temperature (°C)	Frequency Error (Hz)	Frequency Error (ppm)
65	-6,84	-0,008351648
60	2,35	0,002869353
+50	-2.43	-0.002967033
+40	-2.97	-0.003626374
+30	-6.85	-0.008363858
+20	0.59	0.000720391
+10	-2.41	-0.002942613
0	-1.18	-0.001440781
-10	1.62	0.001978022
-20	1.02	0.001245421
-30	1.09	0.001330891
-40	-2,56	-0,003125763

- Frequency Stability over Voltage Variations.**

Battery Supply voltage	Voltage (V)	Frequency Error (Hz)	Frequency Error (ppm)
Vmax	4,6	0,39	0,00047619
Vmin	3,2	-3,45	-0,004212454

Measurement uncertainty (Hz)  $\leq \pm 249.55$

**Results**

PASS

## Modulation Characteristics

### Limits

#### 1. LTE Cat-4 Band 14:

- \* FCC § 2.1047: Measurements required: Modulation characteristics.
- \* RSS-140 Clause 4.1: Equipment shall employ digital modulation techniques.

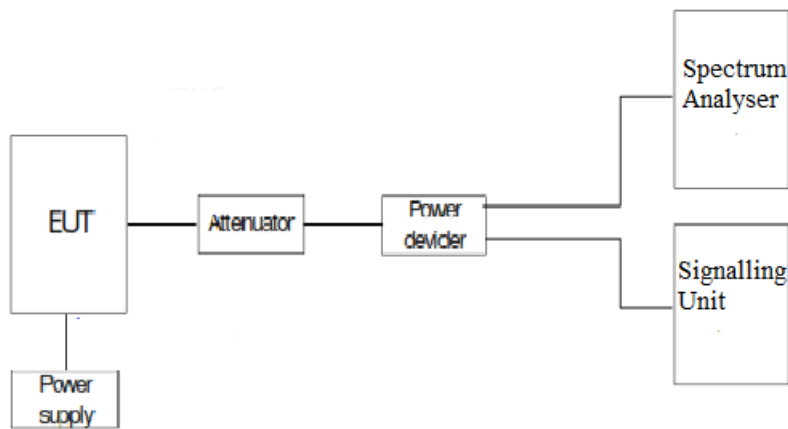
#### 2. LTE Cat-4 Band 26:

- \* FCC § 2.1047: Measurements required: Modulation characteristics.

### Method

For LTE the EUT operates with QPSK and 16QAM modes in which the information is digitised and coded into a bit stream. The RF transmission is multiplexed using *Orthogonal Frequency Division Multiplexing (OFDM)* using different possible arrangement of subcarriers (Resource Blocks RB).

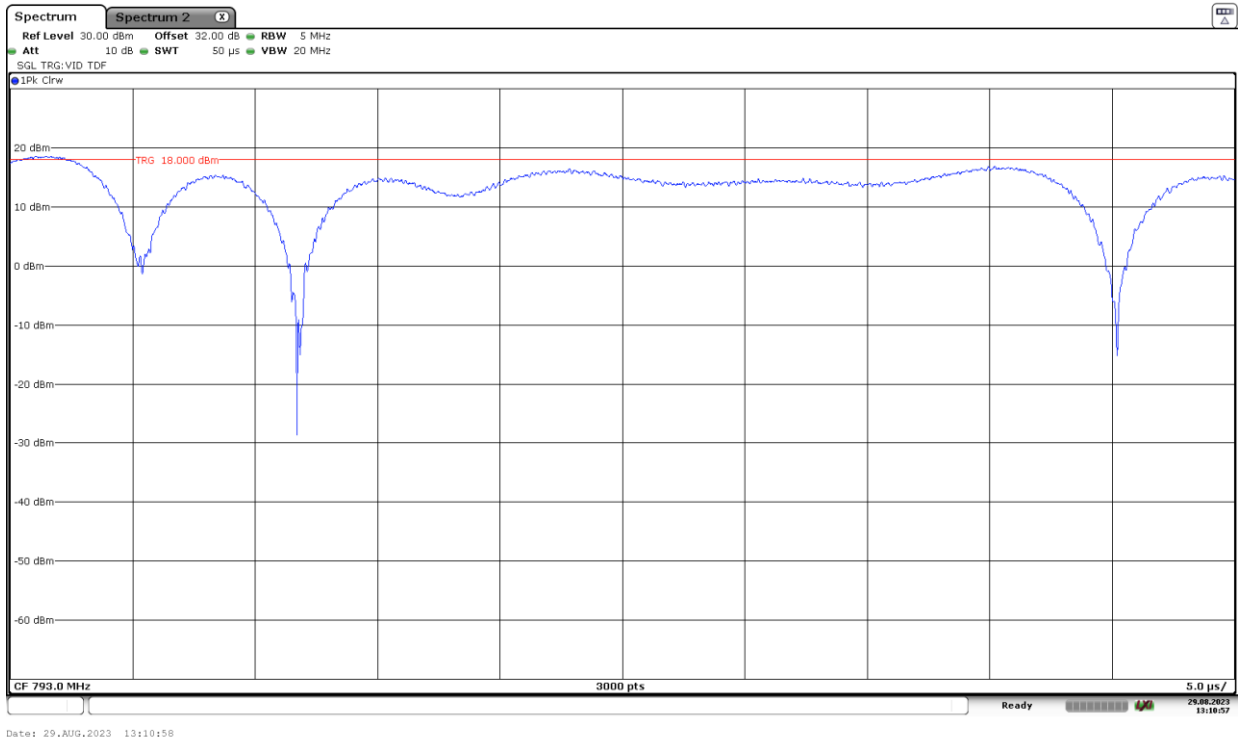
### Test Setup



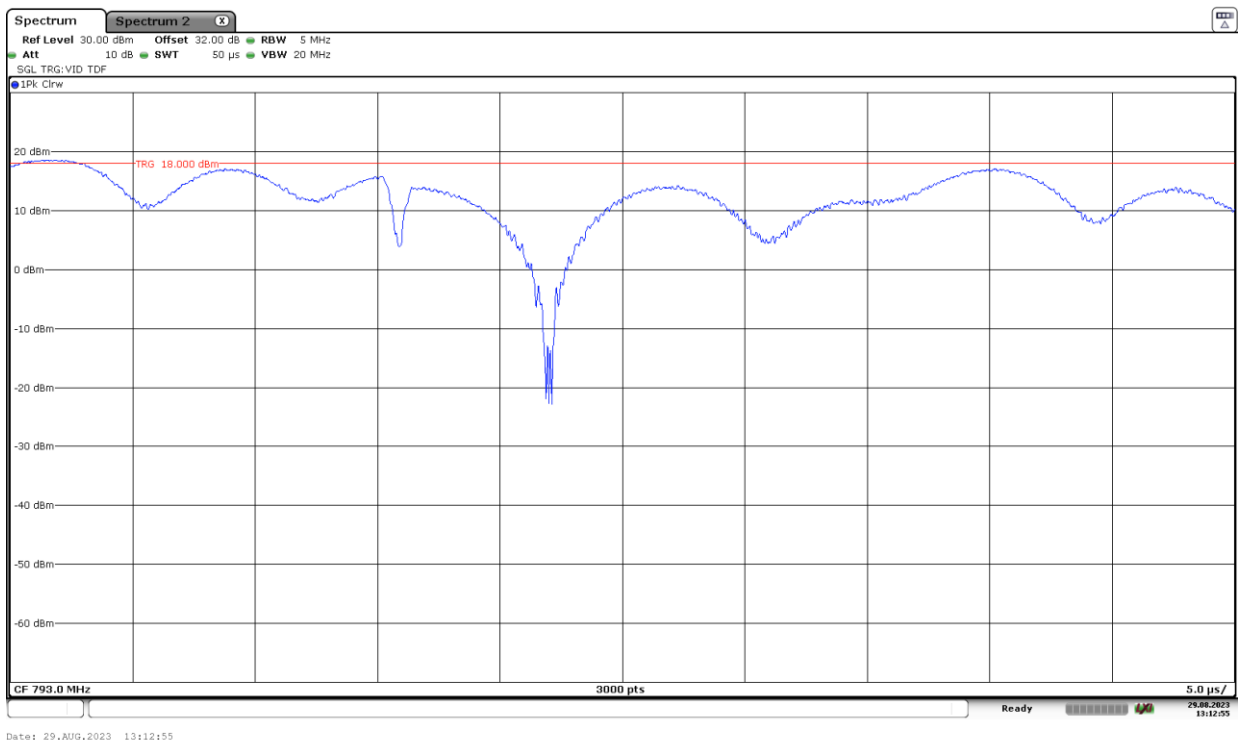
## Results

The following plots show the modulation schemes in the EUT.

### LTE Cat-4 Band 14: BW = 10 MHz. QPSK.



### LTE Cat-4 Band 14: BW = 10 MHz. 16QAM.





## Occupied Bandwidth

### Limits

#### 1. LTE Cat-4 Band 14:

\* FCC § 2.1049. Measurements required: Occupied bandwidth.

\* RSS-Gen Clause 6.7: The occupied bandwidth or the “99% emission bandwidth” is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

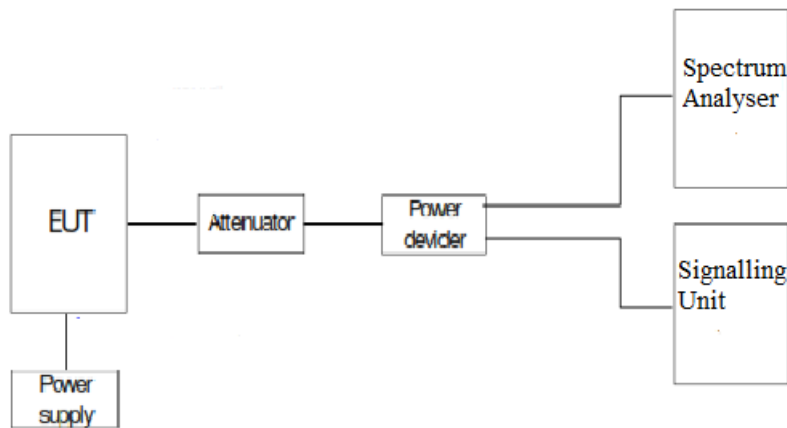
#### 2. LTE Cat-4 Band 26:

\* FCC § 2.1049. Measurements required: Occupied bandwidth.

### Method

The occupied bandwidth measurement was performed at the output terminals of the EUT using an attenuator, power splitter and spectrum analyser. The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation. The 99% occupied bandwidth and the -26 dBc bandwidth were measured directly using the built-in bandwidth measuring option of spectrum analyser.

### Test Setup



**Results**

**LTE Bands:** The worst case of Occupied Bandwidth corresponds to Resource Blocks (RB) Max., regardless the nominal bandwidth selected.

**LTE Cat-4 Band 14:**

LTE Cat-4 Band 14. BW = 5 MHz. QPSK. RB Size=Max.

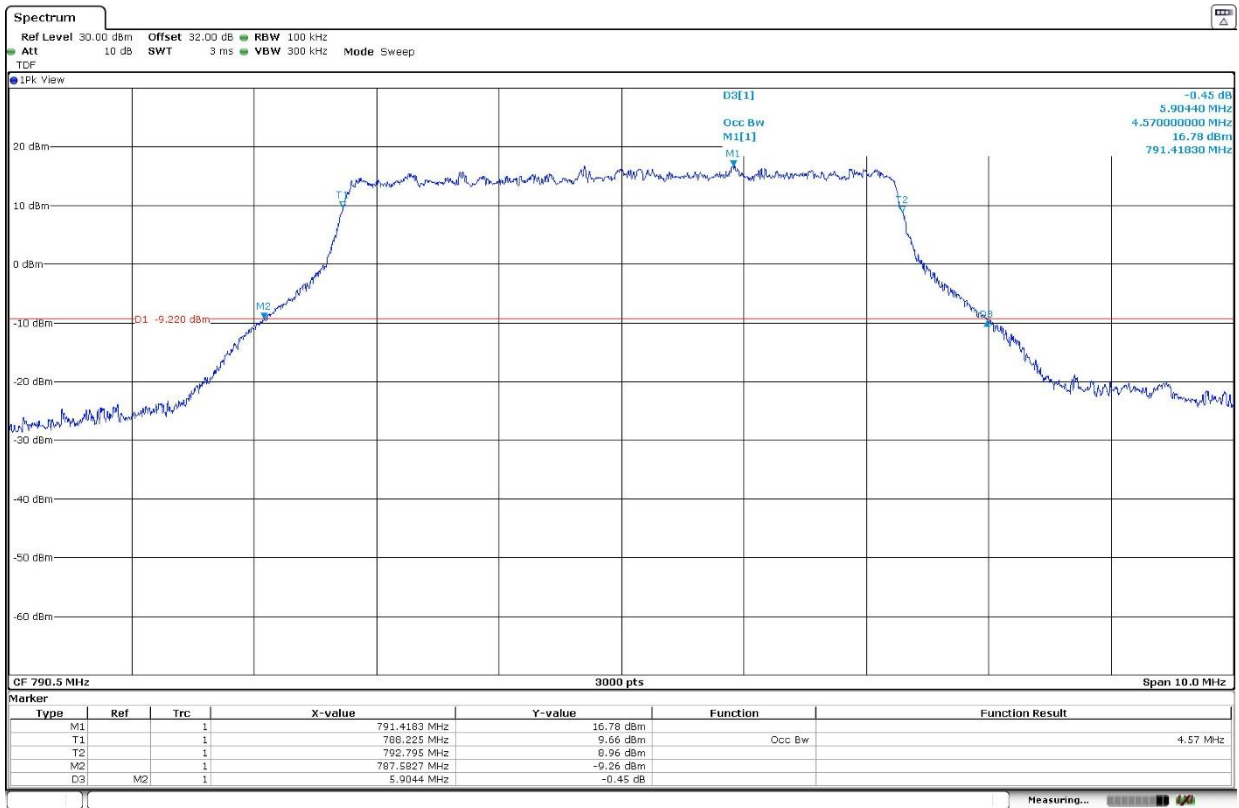
	Low Channel	High Channel
99% Occupied Bandwidth (MHz)	4.570	4.603
-26 dBc Bandwidth (MHz)	5.904	5.960
Measurement uncertainty (kHz)	<±4.67	

LTE Cat-4 Band 14. BW = 5 MHz. 16QAM. RB Size = Max.

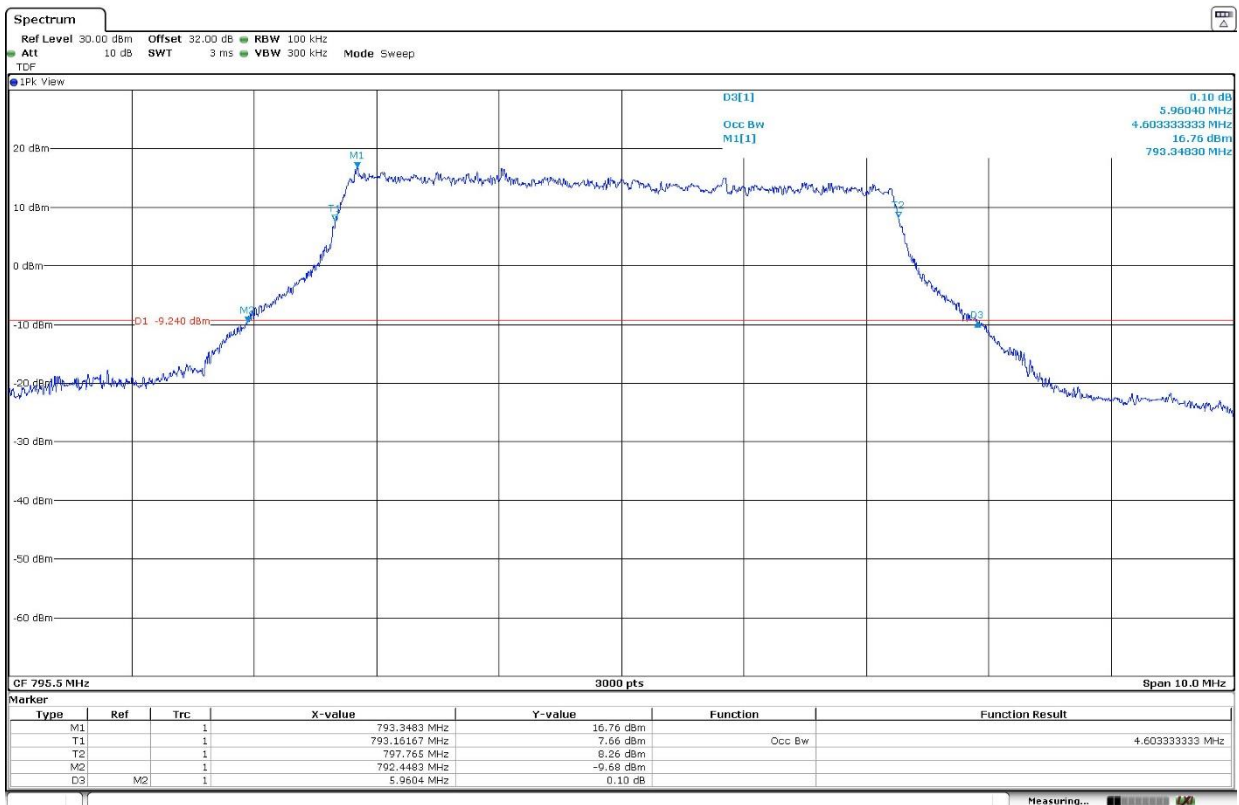
	Low Channel	High Channel
99% Occupied Bandwidth (MHz)	4.577	4.623
-26 dBc Bandwidth (MHz)	5.971	6.070
Measurement uncertainty (kHz)	<±4.67	

LTE Cat-4 Band 14. BW = 5 MHz. QPSK.

Low Channel:

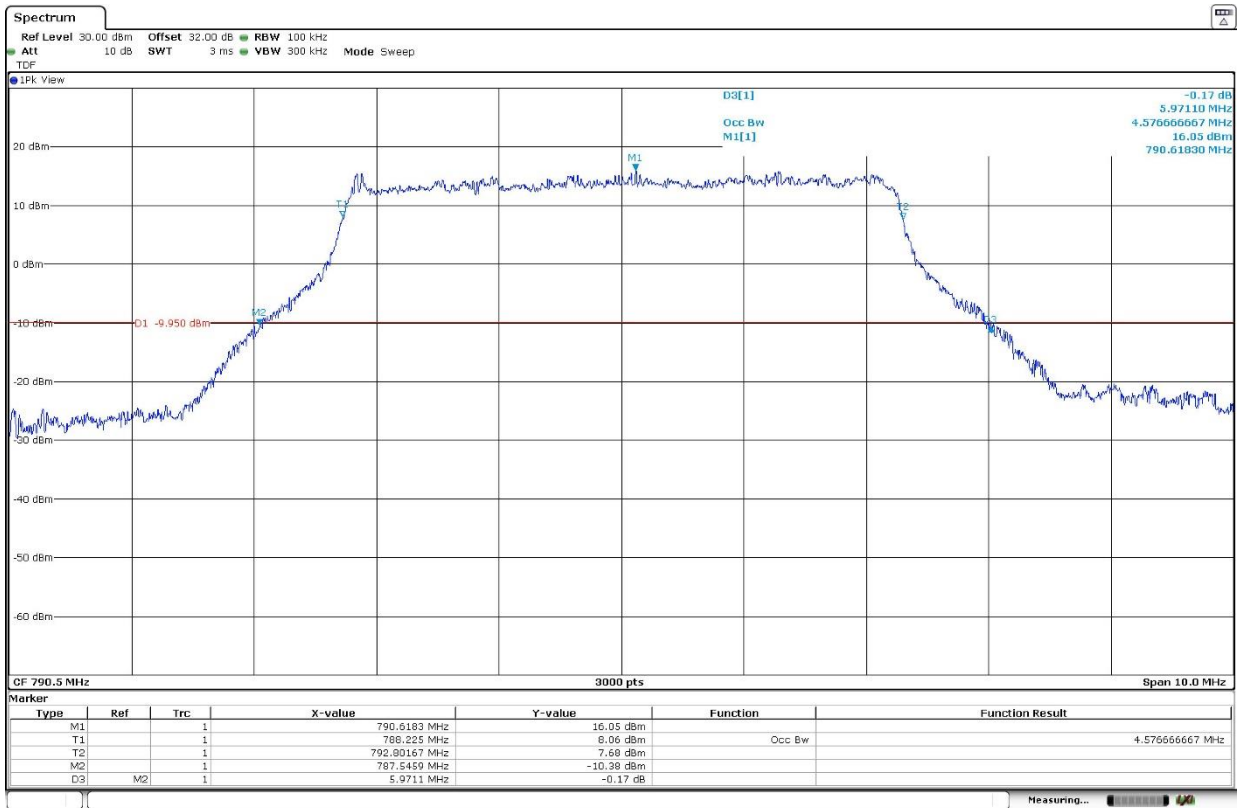


High Channel:

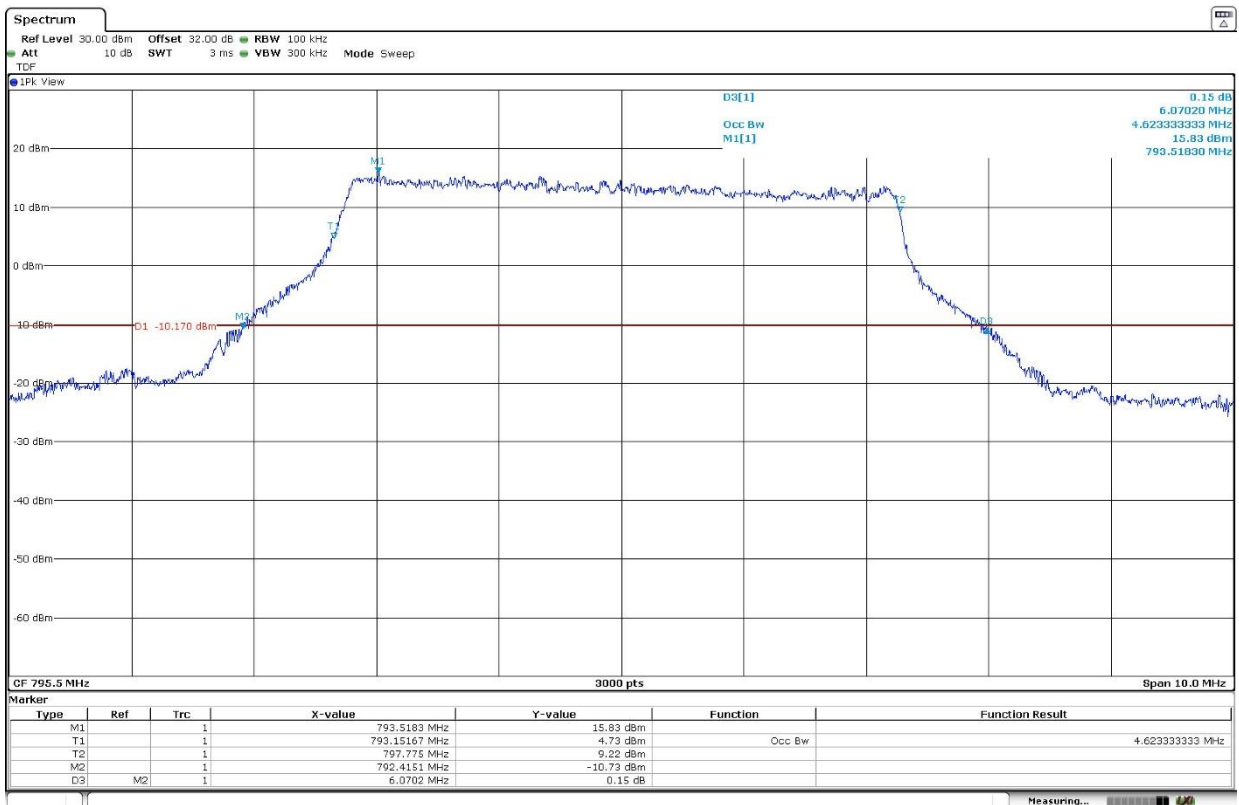


LTE Cat-4 Band 14. BW = 5 MHz. 16QAM.

Low Channel:



High Channel:





LTE Cat-4 Band 14. BW = 10 MHz. QPSK. RB Size=Max.

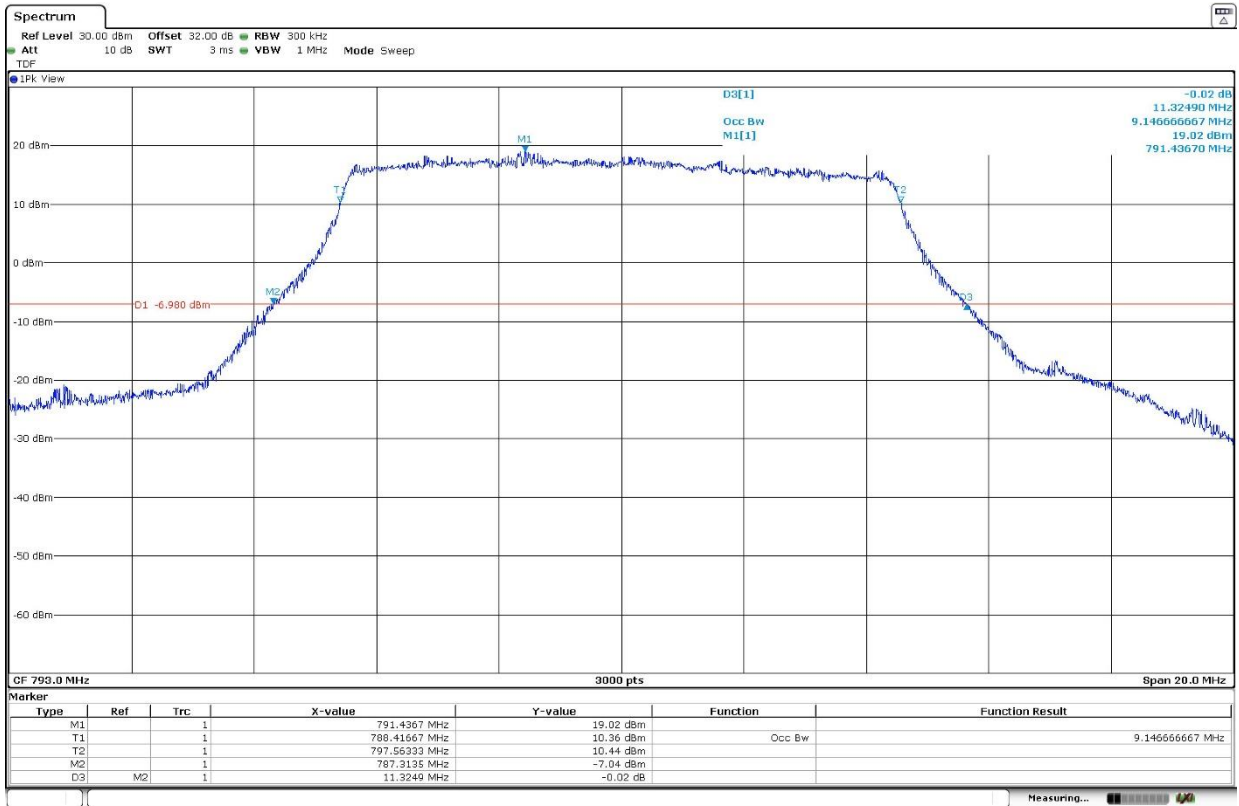
	Middle Channel
99% Occupied Bandwidth (MHz)	9.147
-26 dBc Bandwidth (MHz)	11.325
Measurement uncertainty (kHz)	<±4.67

LTE Cat-4 Band 14. BW = 10 MHz. 16QAM. RB Size = Max.

	Middle Channel
99% Occupied Bandwidth (MHz)	9.120
-26 dBc Bandwidth (MHz)	11.439
Measurement uncertainty (kHz)	<±4.67

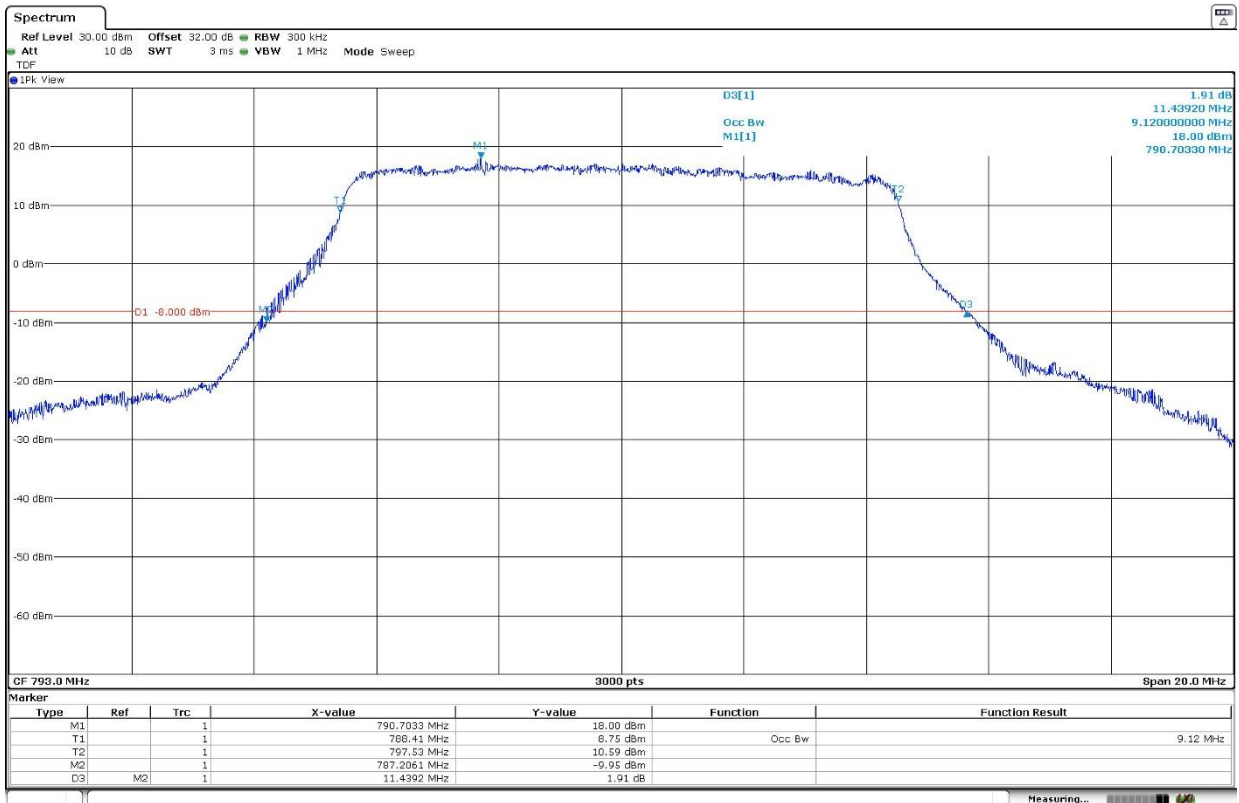
LTE Cat-4 Band 14. BW = 10 MHz. QPSK.

Middle Channel:



LTE Cat-4 Band 14. BW = 10 MHz. 16QAM.

Middle Channel:



**LTE Cat-4 Band 26. Sub-band 814-824 MHz:**

LTE Cat-4 Band 26. Sub-band 814-824 MHz. BW = 1.4 MHz. QPSK. RB Size = All.

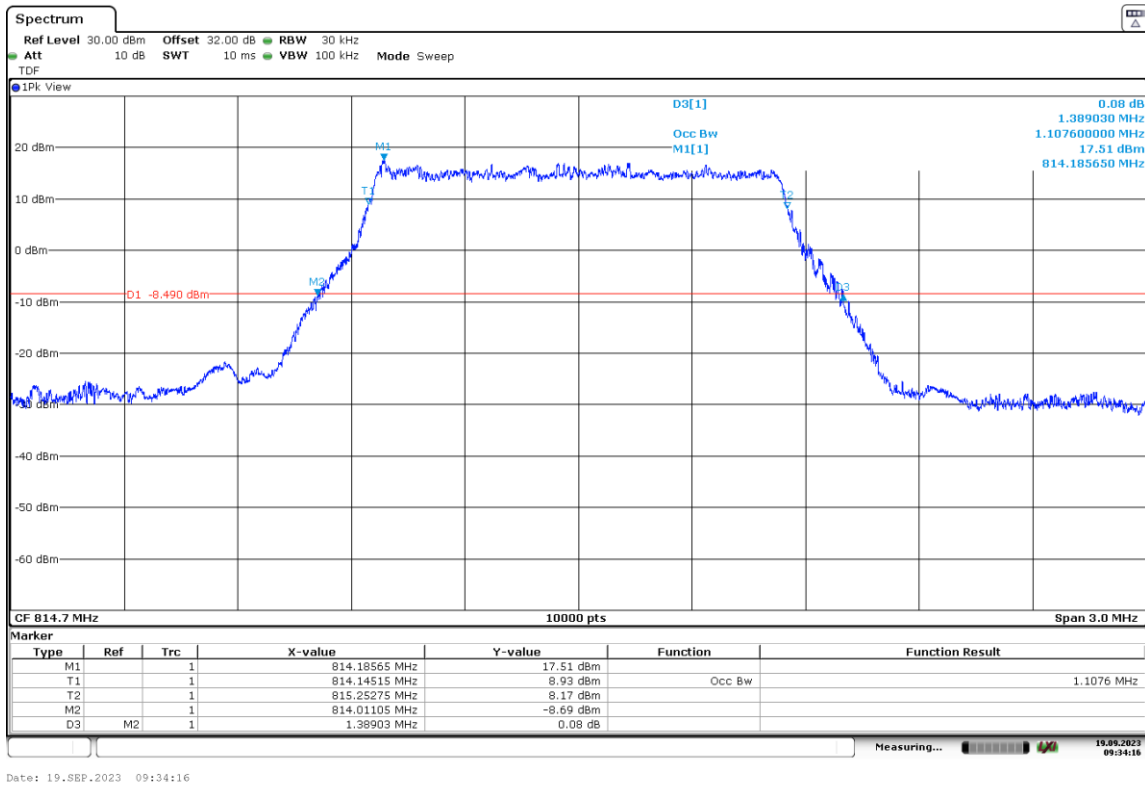
	Low Channel	High Channel
99% Occupied Bandwidth (MHz)	1.108	1.104
-26 dBc Bandwidth (MHz)	1.389	1.377
Measurement uncertainty (kHz)	<±4.67	

LTE Cat-4 Band 26. Sub-band 814-824 MHz. BW = 1.4 MHz. 16QAM. RB Size = All.

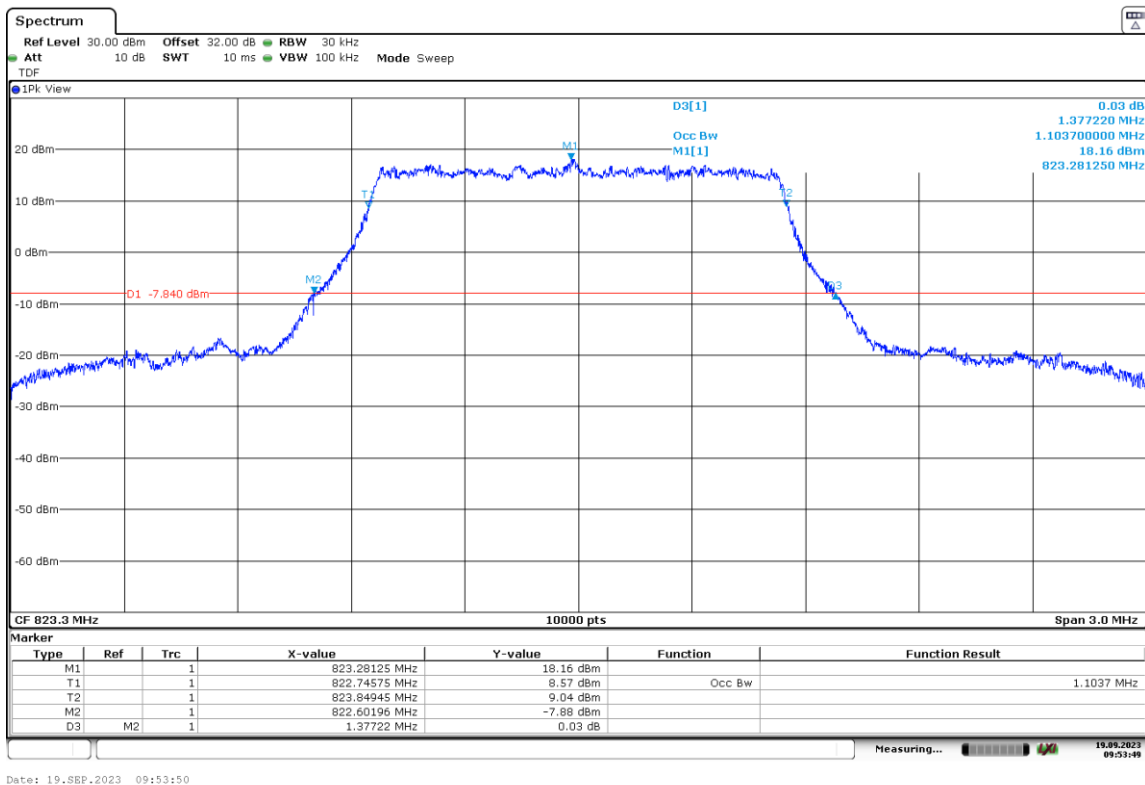
	Low Channel	High Channel
99% Occupied Bandwidth (MHz)	1.106	1.115
-26 dBc Bandwidth (MHz)	1.379	1.385
Measurement uncertainty (kHz)	<±4.67	

LTE Cat-4 Band 26. Sub-band 814-824 MHz. BW = 1.4 MHz. QPSK.

Low Channel:

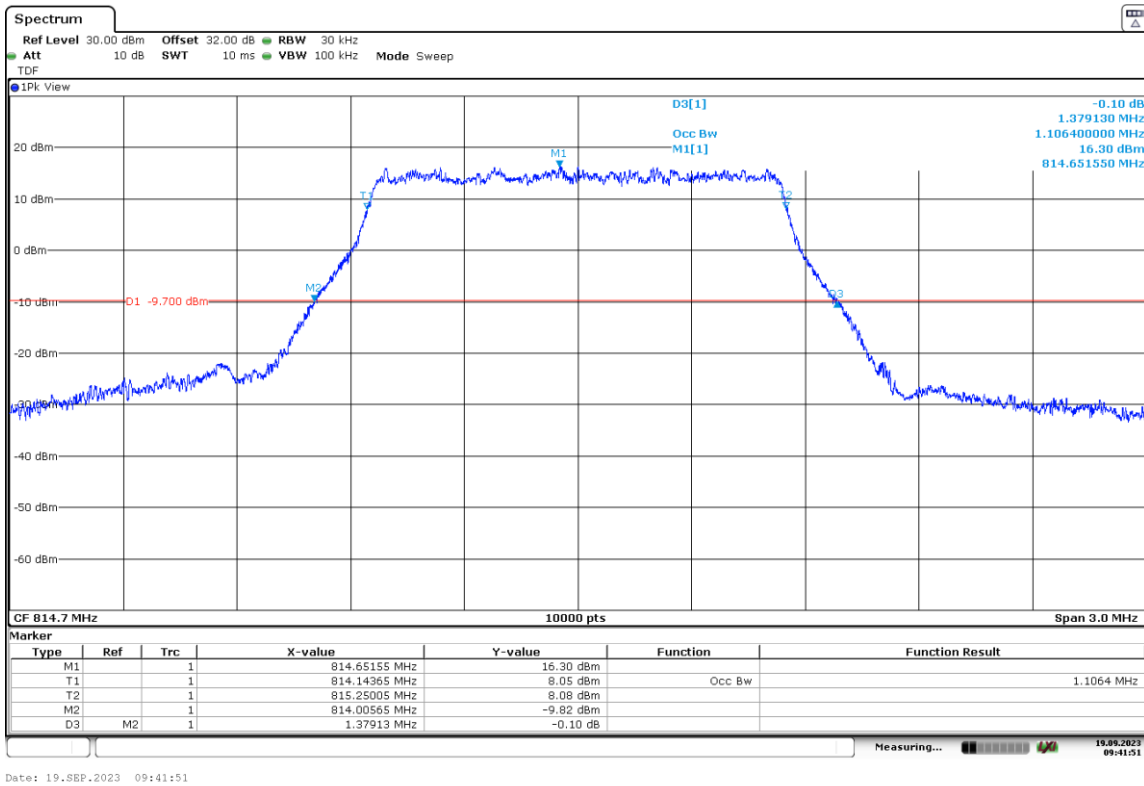


High Channel:

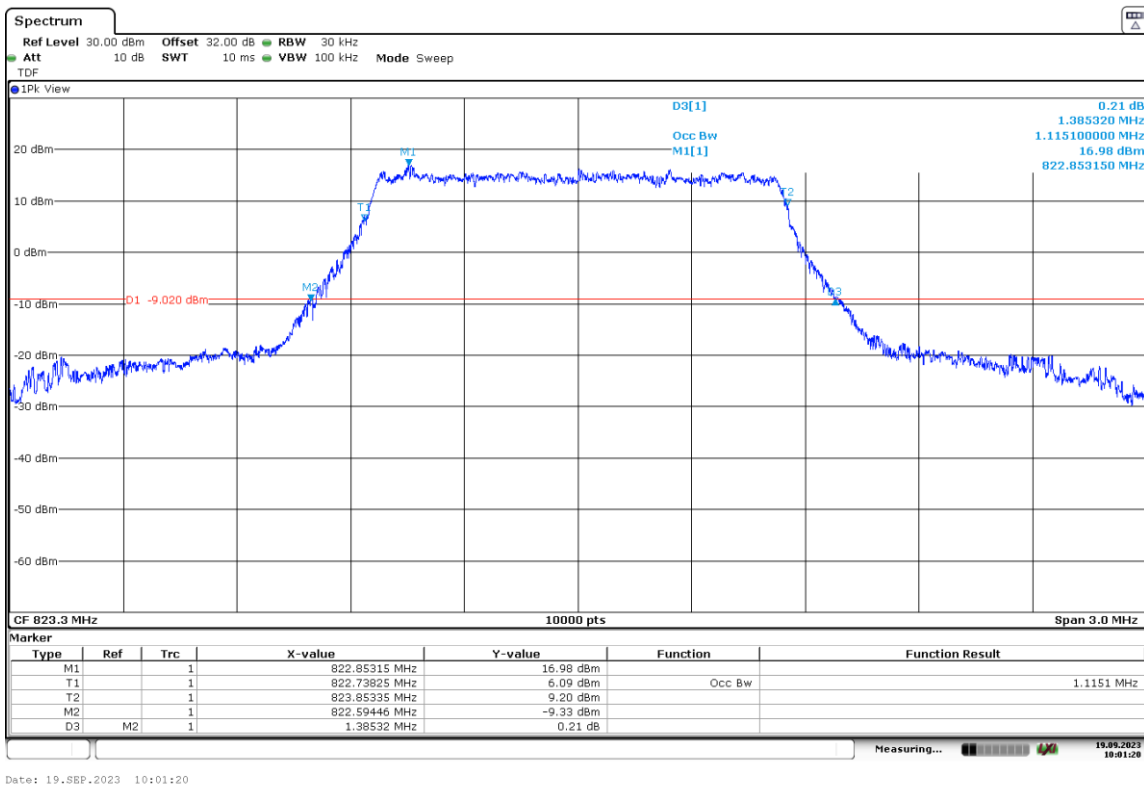


LTE Cat-4 Band 26. Sub-band 814-824 MHz. BW = 1.4 MHz. 16QAM.

Low Channel:



High Channel:



LTE Cat-4 Band 26. Sub-band 814-824 MHz. BW = 3 MHz. QPSK. RB Size = All.

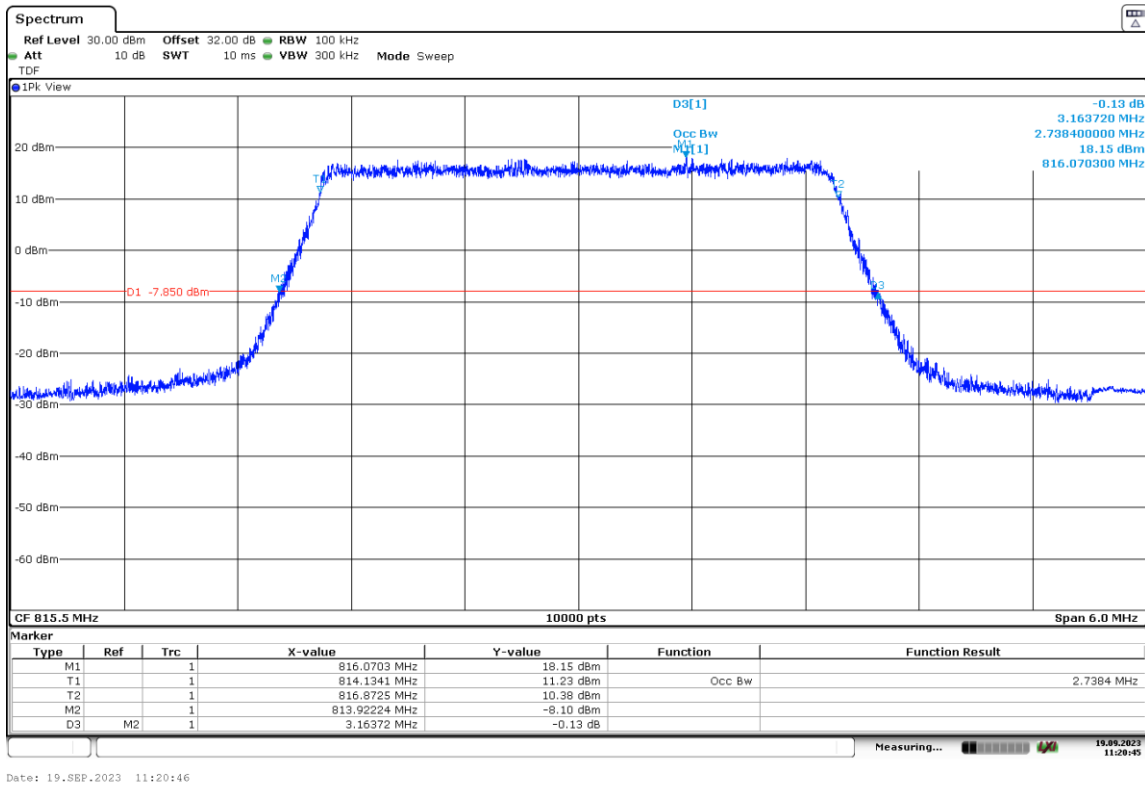
	Low Channel	High Channel
99% Occupied Bandwidth (MHz)	2.738	2.735
-26 dBc Bandwidth (MHz)	3.164	3.174
Measurement uncertainty (kHz)	<±4.67	

LTE Cat-4 Band 26. Sub-band 814-824 MHz. BW = 3 MHz. 16QAM. RB Size = All.

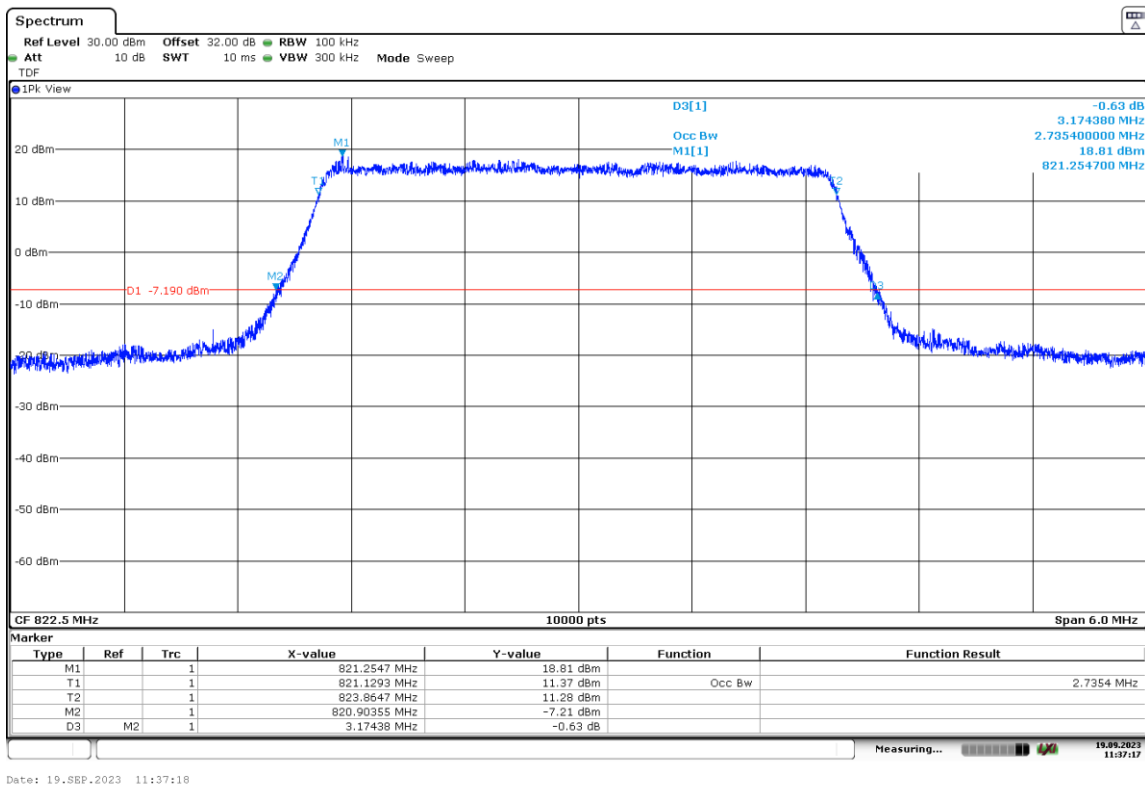
	Low Channel	High Channel
99% Occupied Bandwidth (MHz)	2.740	2.749
-26 dBc Bandwidth (MHz)	3.160	3.238
Measurement uncertainty (kHz)	<±4.67	

LTE Cat-4 Band 26. Sub-band 814-824 MHz. BW = 3 MHz. QPSK.

Low Channel:

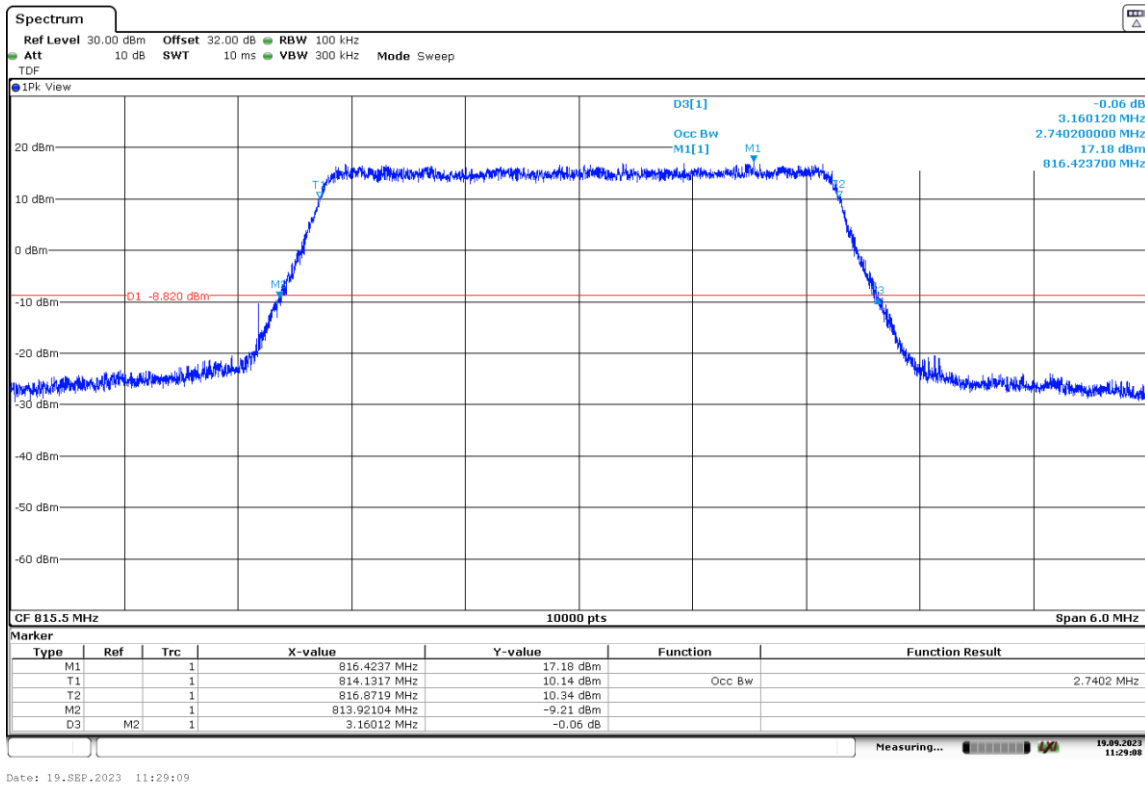


High Channel:

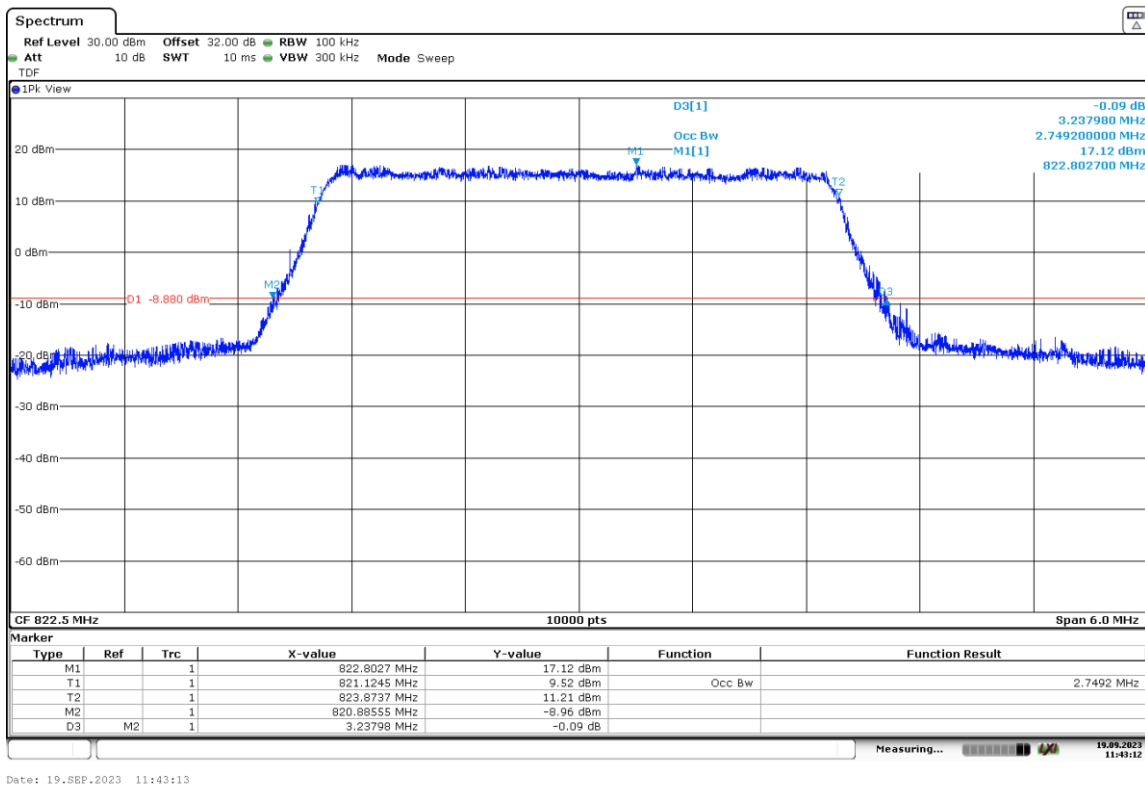


LTE Cat-4 Band 26. Sub-band 814-824 MHz. BW = 3 MHz. 16QAM.

Low Channel:



High Channel:





LTE Cat-4 Band 26. Sub-band 814-824 MHz. BW = 5 MHz. QPSK. RB Size = All.

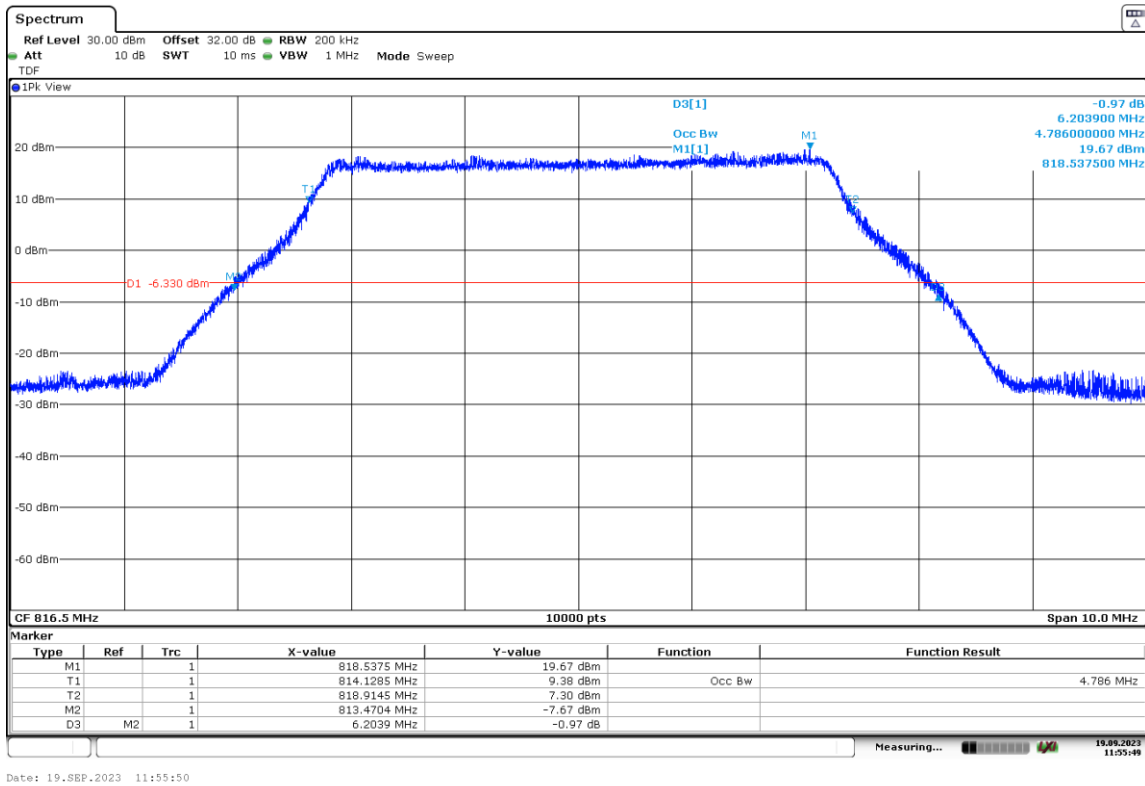
	Low Channel	High Channel
99% Occupied Bandwidth (MHz)	4.786	4.742
-26 dBc Bandwidth (MHz)	6.204	6.317
Measurement uncertainty (kHz)	<±4.67	

LTE Cat-4 Band 26. Sub-band 814-824 MHz. BW = 5 MHz. 16QAM. RB Size = All.

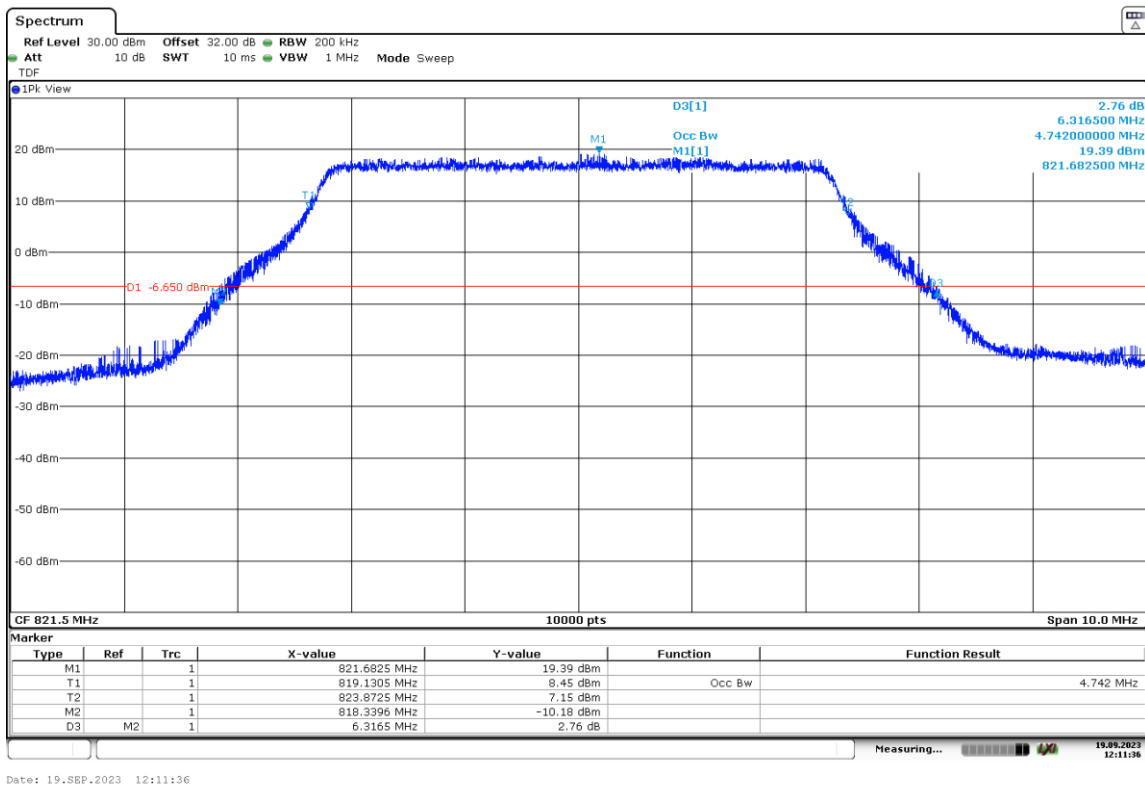
	Low Channel	High Channel
99% Occupied Bandwidth (MHz)	4.826	4.726
-26 dBc Bandwidth (MHz)	6.326	6.168
Measurement uncertainty (kHz)	<±4.67	

LTE Cat-4 Band 26. Sub-band 814-824 MHz. BW = 5 MHz. QPSK.

Low Channel:

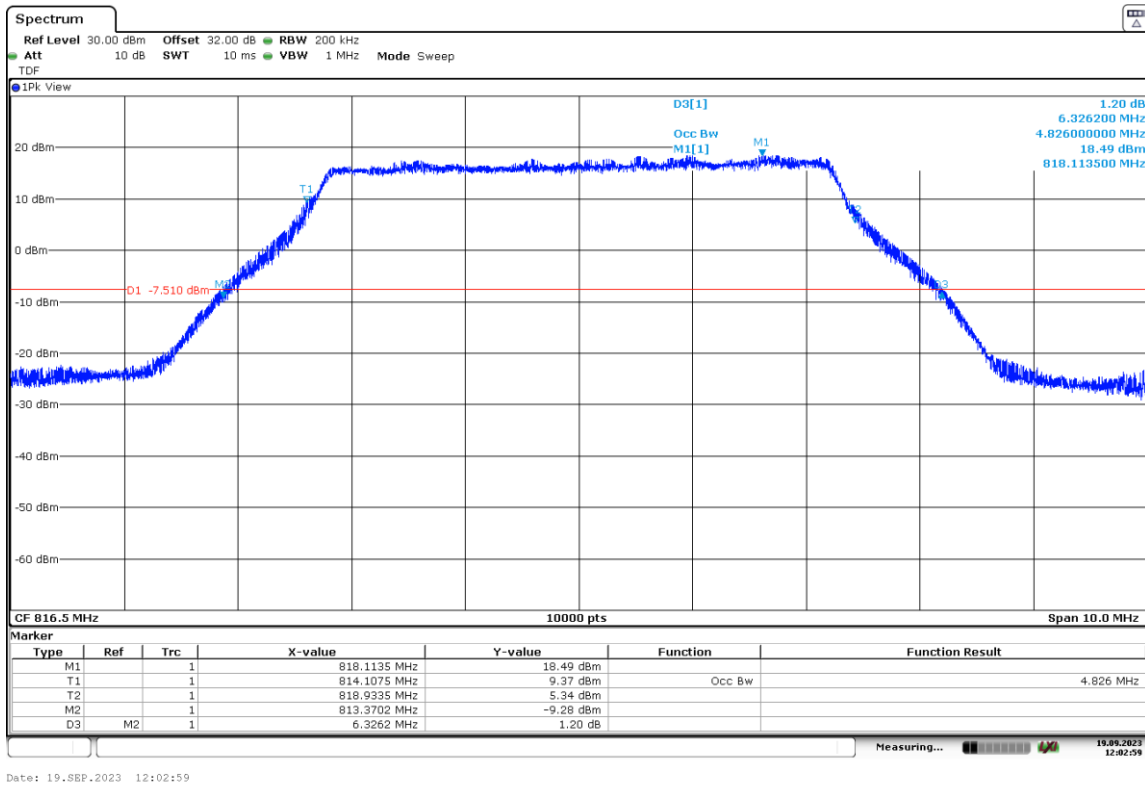


High Channel:

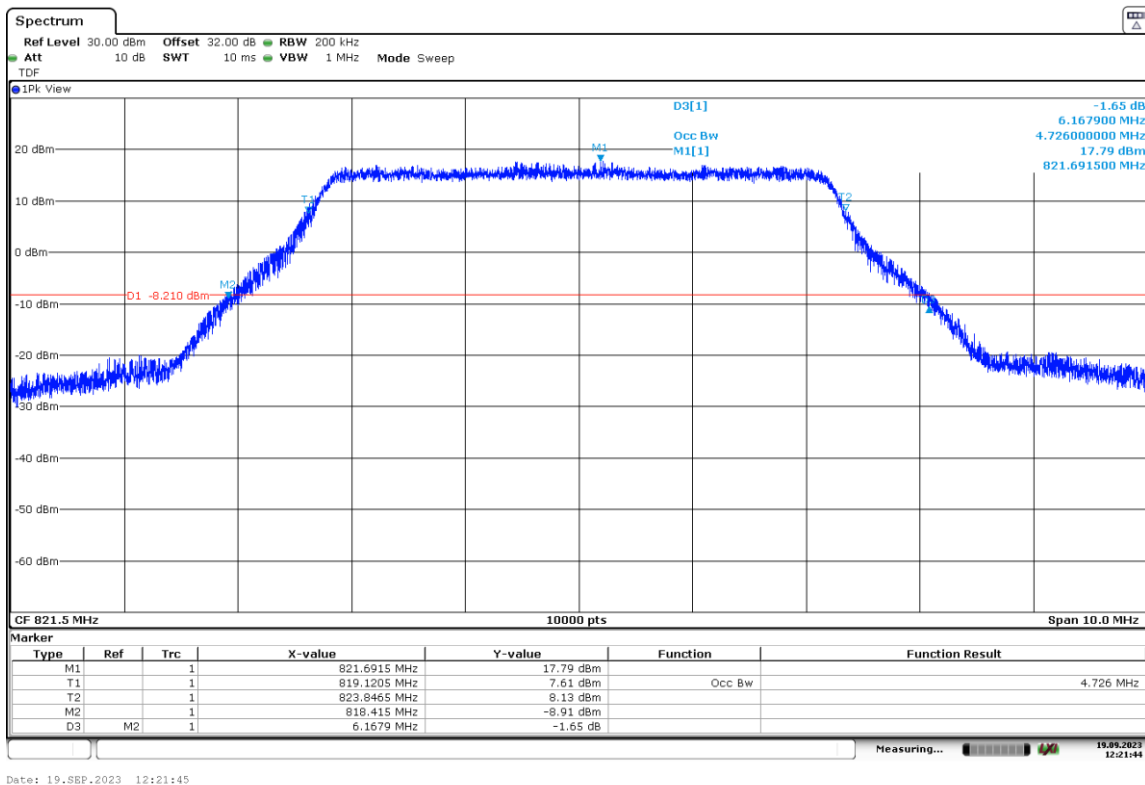


LTE Cat-4 Band 26. Sub-band 814-824 MHz. BW = 5 MHz. 16QAM.

Low Channel:



High Channel:



LTE Cat-4 Band 26. Sub-band 814-824 MHz. BW = 10 MHz. QPSK. RB Size = All.

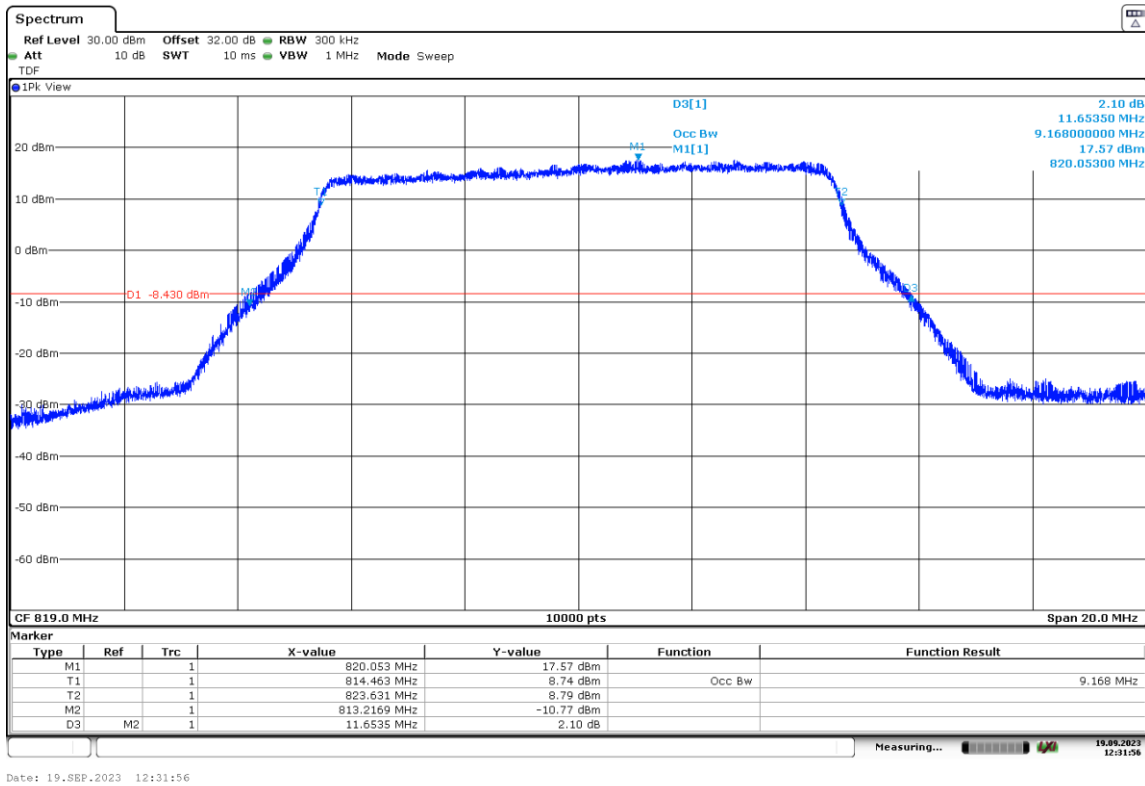
	Middle Channel
99% Occupied Bandwidth (MHz)	9.168
-26 dBc Bandwidth (MHz)	11.654
Measurement uncertainty (kHz)	<±4.67

LTE Cat-4 Band 26. Sub-band 814-824 MHz. BW = 10 MHz. 16QAM. RB Size = All.

	Middle Channel
99% Occupied Bandwidth (MHz)	9.108
-26 dBc Bandwidth (MHz)	11.480
Measurement uncertainty (kHz)	<±4.67

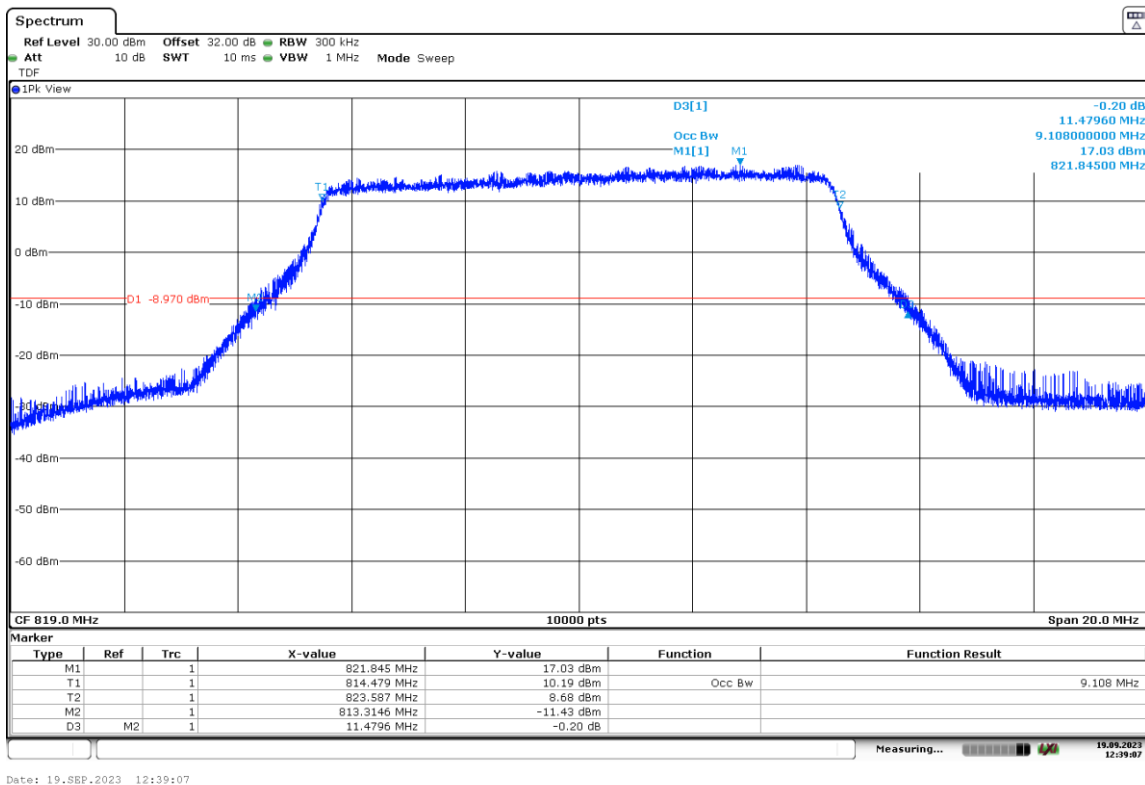
LTE Cat-4 Band 26. Sub-band 814-824 MHz. BW = 10 MHz. QPSK.

Middle Channel:



LTE Cat-4 Band 26. Sub-band 814-824 MHz. BW = 10 MHz. 16QAM.

Middle Channel:



**LTE Cat-4 Band 26. Cross-rule Channel 824 MHz:**

LTE Cat-4 Band 26. Cross-rule Channel 824 MHz. BW = 1.4 MHz. QPSK. RB Size = All.

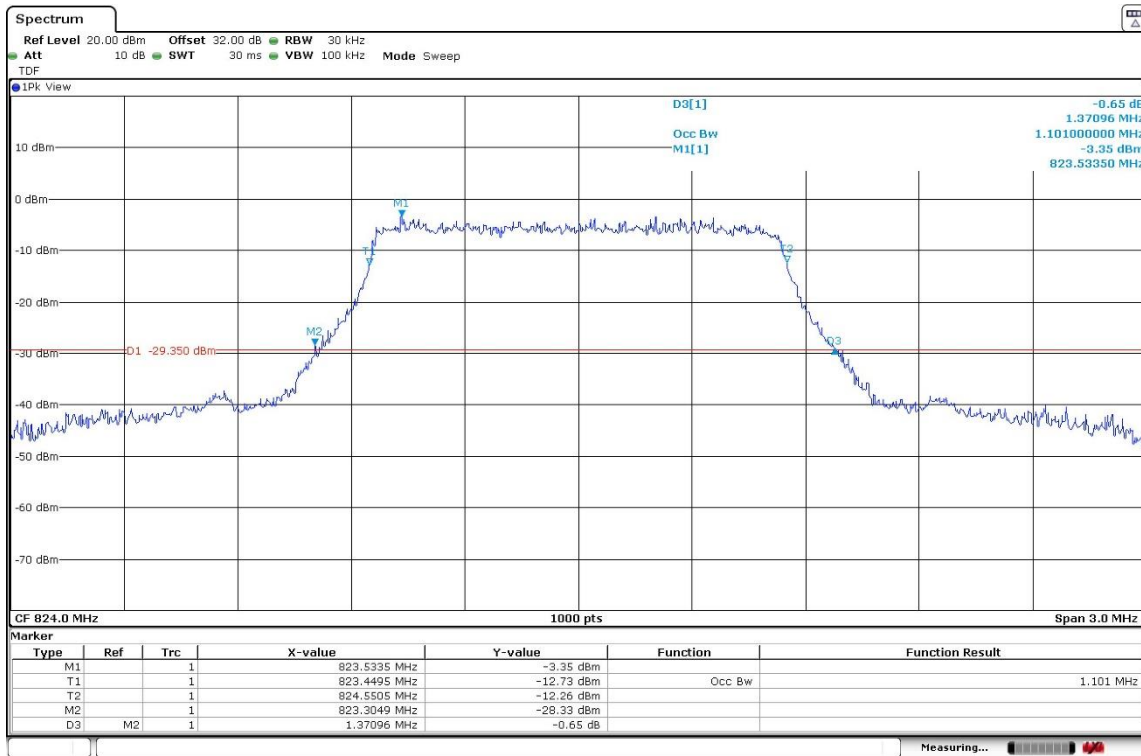
	Single Channel
99% Occupied Bandwidth (MHz)	1.101000
-26 dBc Bandwidth (MHz)	1.370960
Measurement uncertainty (kHz)	<±4.67

LTE Cat-4 Band 26. Cross-rule Channel 824 MHz. BW = 1.4 MHz. 16QAM. RB Size = All.

	Single Channel
99% Occupied Bandwidth (MHz)	1.110000
-26 dBc Bandwidth (MHz)	1.400960
Measurement uncertainty (kHz)	<±4.67

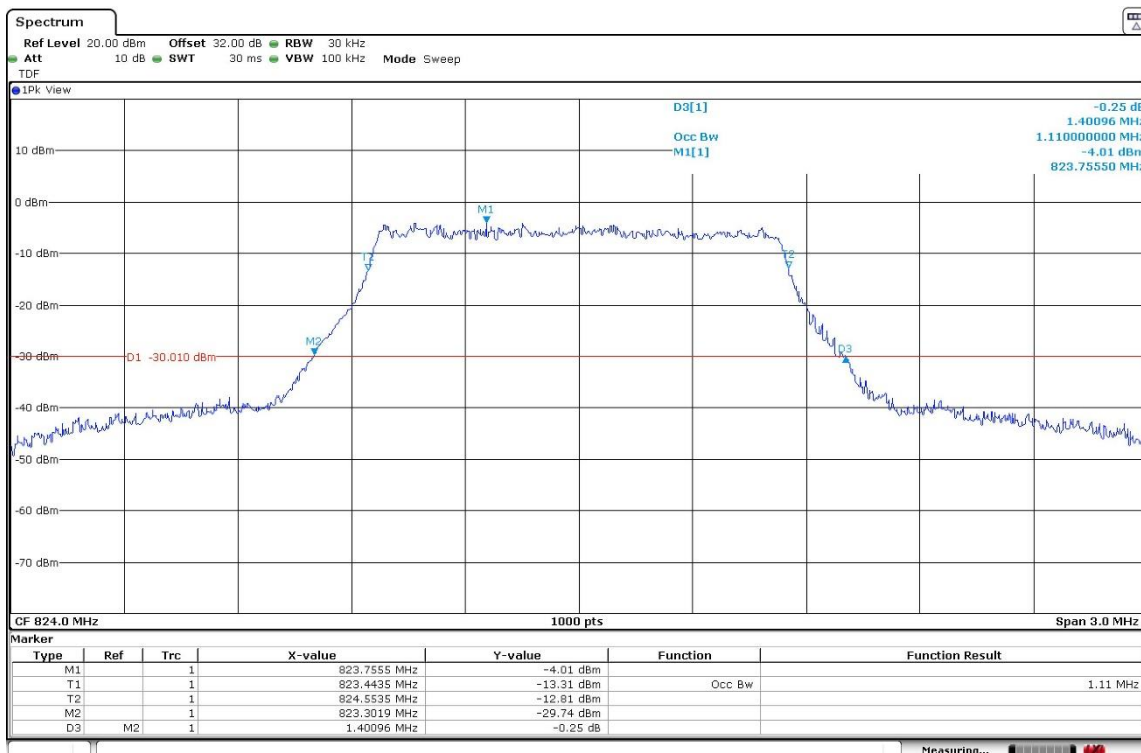
LTE Cat-4 Band 26. Cross-rule Channel 824 MHz. BW = 1.4 MHz. QPSK.

Cross-rule Channel 824 MHz:



LTE Cat-4 Band 26. Cross-rule Channel 824 MHz. BW = 1.4 MHz. 16QAM.

Cross-rule Channel 824 MHz:



LTE Cat-4 Band 26. Cross-rule Channel 824 MHz. BW = 3 MHz. QPSK. RB Size = All.

	Single Channel
99% Occupied Bandwidth (MHz)	2.742000
-26 dBc Bandwidth (MHz)	3.172470
Measurement uncertainty (kHz)	<±4.67

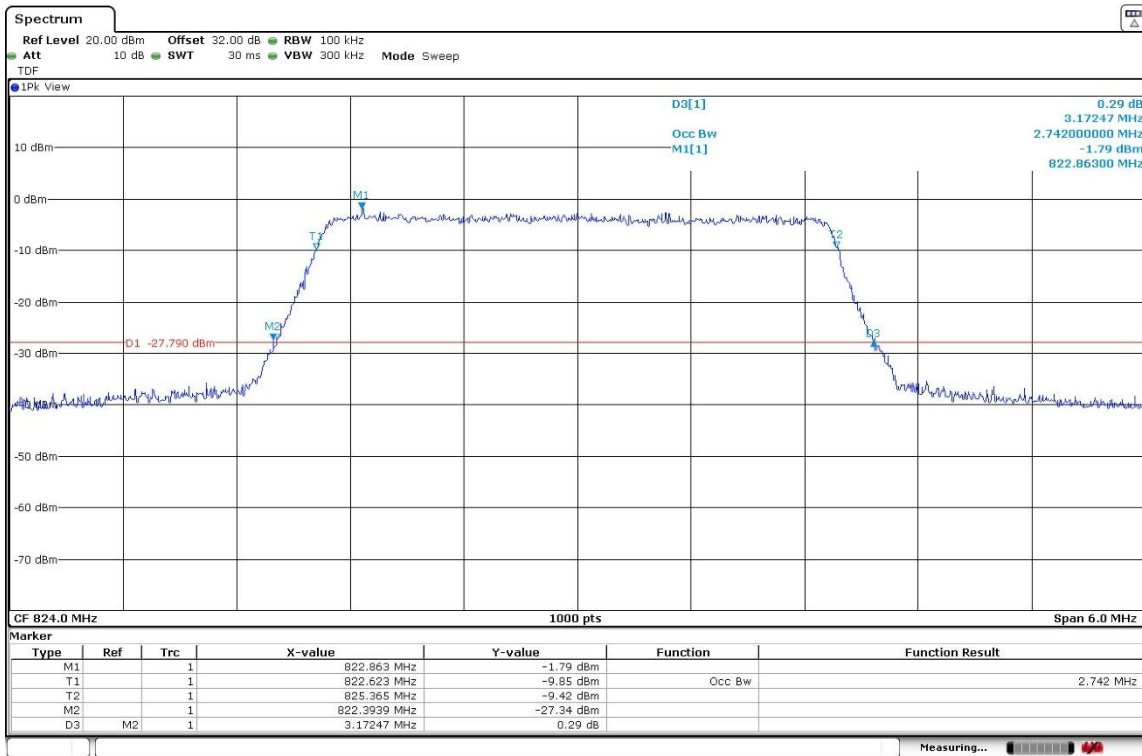
LTE Cat-4 Band 26. Cross-rule Channel 824 MHz. BW = 3 MHz. 16QAM. RB Size = All.

	Single Channel
99% Occupied Bandwidth (MHz)	2.754000
-26 dBc Bandwidth (MHz)	3.190470
Measurement uncertainty (kHz)	<±4.67



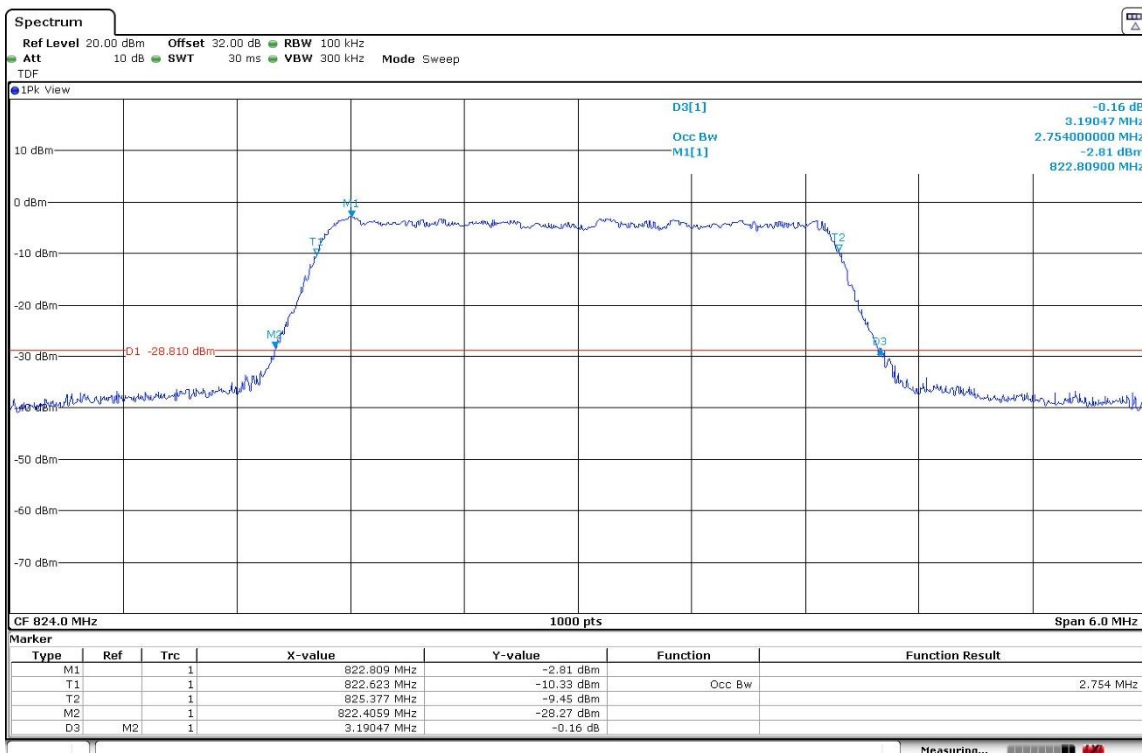
LTE Cat-4 Band 26. Cross-rule Channel 824 MHz. BW = 3 MHz. QPSK.

Cross-rule Channel 824 MHz:



LTE Cat-4 Band 26. Cross-rule Channel 824 MHz. BW = 3 MHz. 16QAM.

Cross-rule Channel 824 MHz:



LTE Cat-4 Band 26. Cross-rule Channel 824 MHz. BW = 5 MHz. QPSK. RB Size = All.

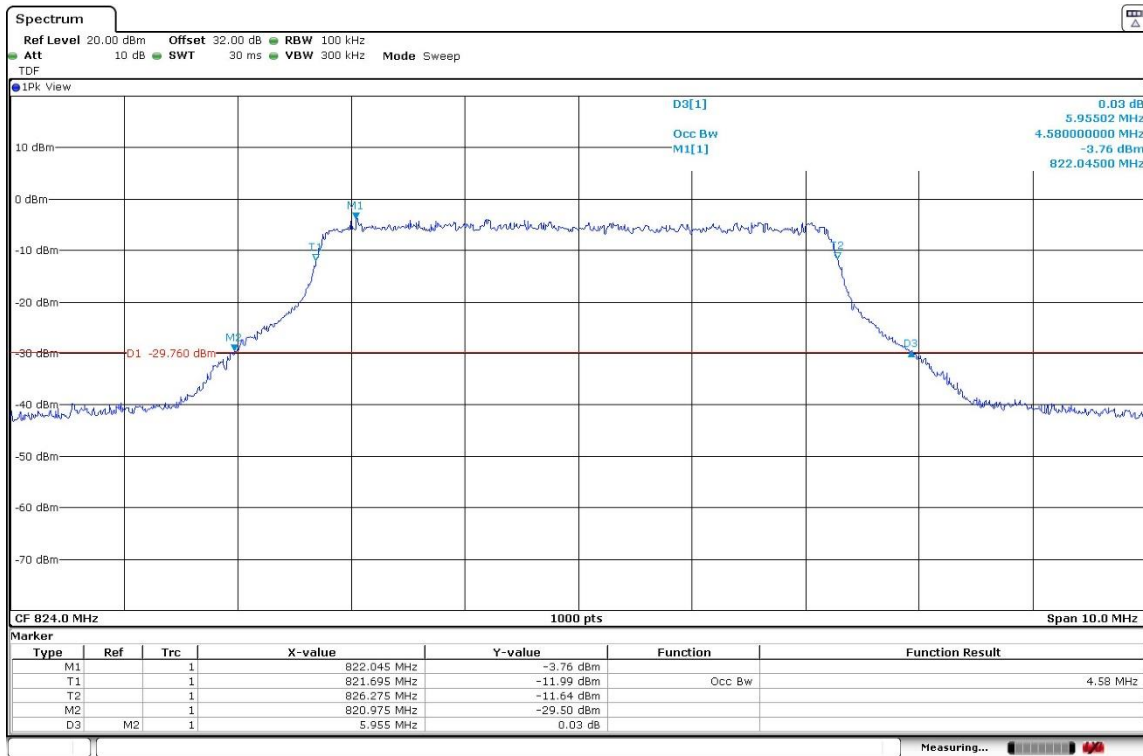
	Single Channel
99% Occupied Bandwidth (MHz)	4.580000
-26 dBc Bandwidth (MHz)	5.955020
Measurement uncertainty (kHz)	<±4.67

LTE Cat-4 Band 26. Cross-rule Channel 824 MHz. BW = 5 MHz. 16QAM. RB Size = All.

	Single Channel
99% Occupied Bandwidth (MHz)	4.590000
-26 dBc Bandwidth (MHz)	5.855020
Measurement uncertainty (kHz)	<±4.67

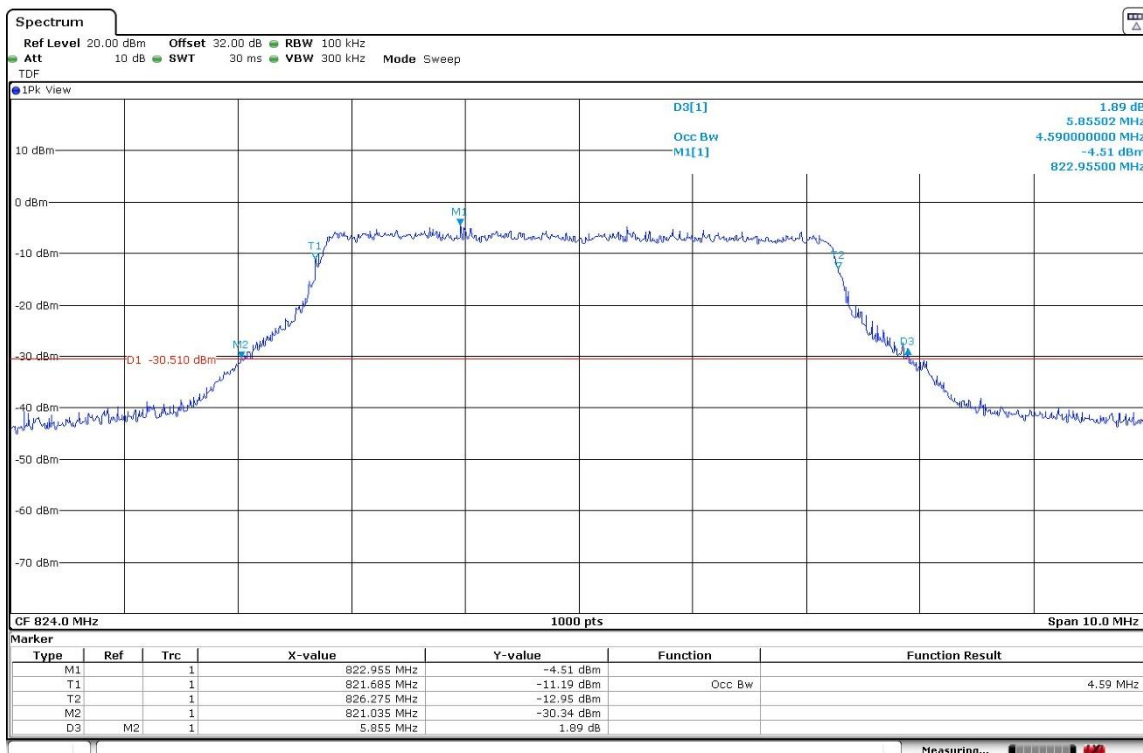
LTE Cat-4 Band 26. Cross-rule Channel 824 MHz. BW = 5 MHz. QPSK.

Cross-rule Channel 824 MHz:



LTE Cat-4 Band 26. Cross-rule Channel 824 MHz. BW = 5 MHz. 16QAM.

Cross-rule Channel 824 MHz:



LTE Cat-4 Band 26. Cross-rule Channel 824 MHz. BW = 10 MHz. QPSK. RB Size = All.

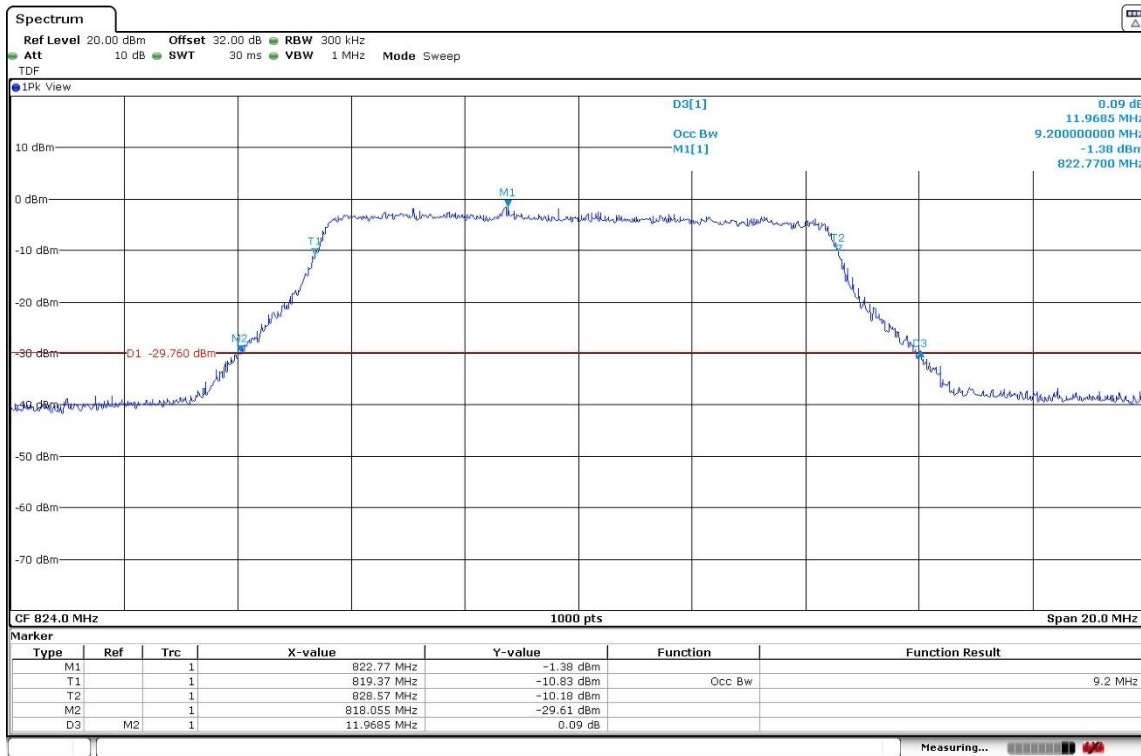
	Single Channel
99% Occupied Bandwidth (MHz)	9.200000
-26 dBc Bandwidth (MHz)	11.968500
Measurement uncertainty (kHz)	<±4.67

LTE Cat-4 Band 26. Cross-rule Channel 824 MHz. BW = 10 MHz. 16QAM. RB Size = All.

	Single Channel
99% Occupied Bandwidth (MHz)	9.240000
-26 dBc Bandwidth (MHz)	11.649000
Measurement uncertainty (kHz)	<±4.67

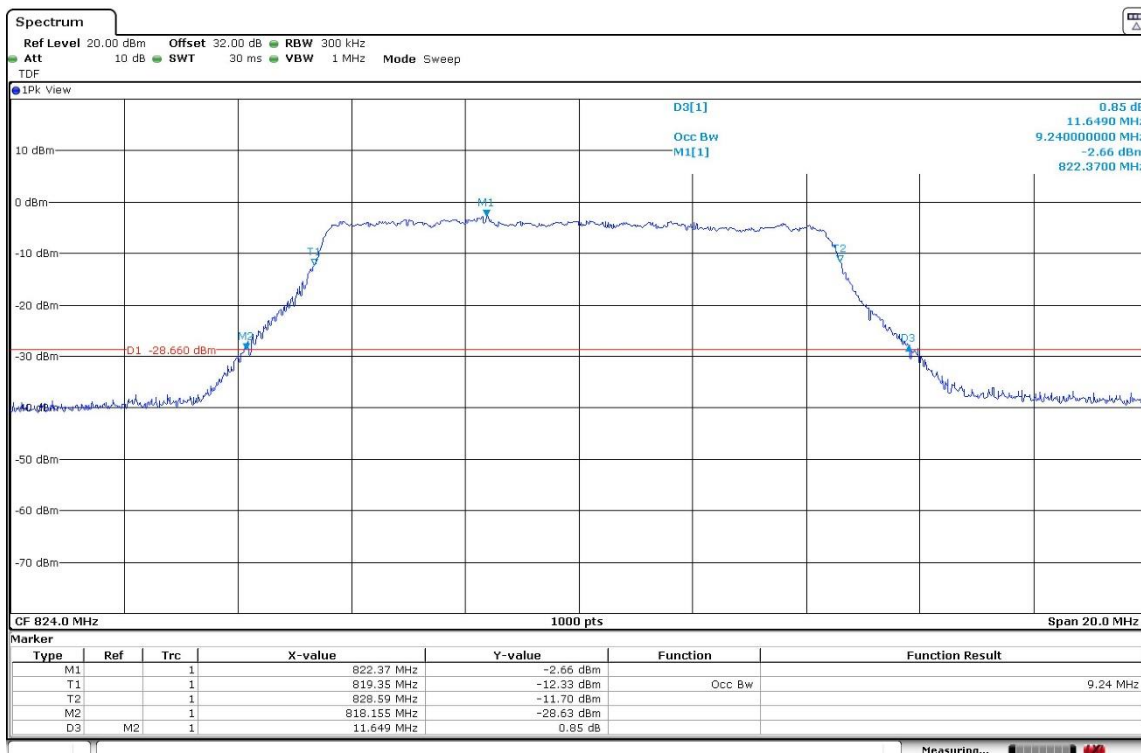
LTE Cat-4 Band 26. Cross-rule Channel 824 MHz. BW = 10 MHz. QPSK.

Cross-rule Channel 824 MHz:



LTE Cat-4 Band 26. Cross-rule Channel 824 MHz. BW = 10 MHz. 16QAM.

Cross-rule Channel 824 MHz:



LTE Cat-4 Band 26. Cross-rule Channel 824 MHz. BW = 15 MHz. QPSK. RB Size = All.

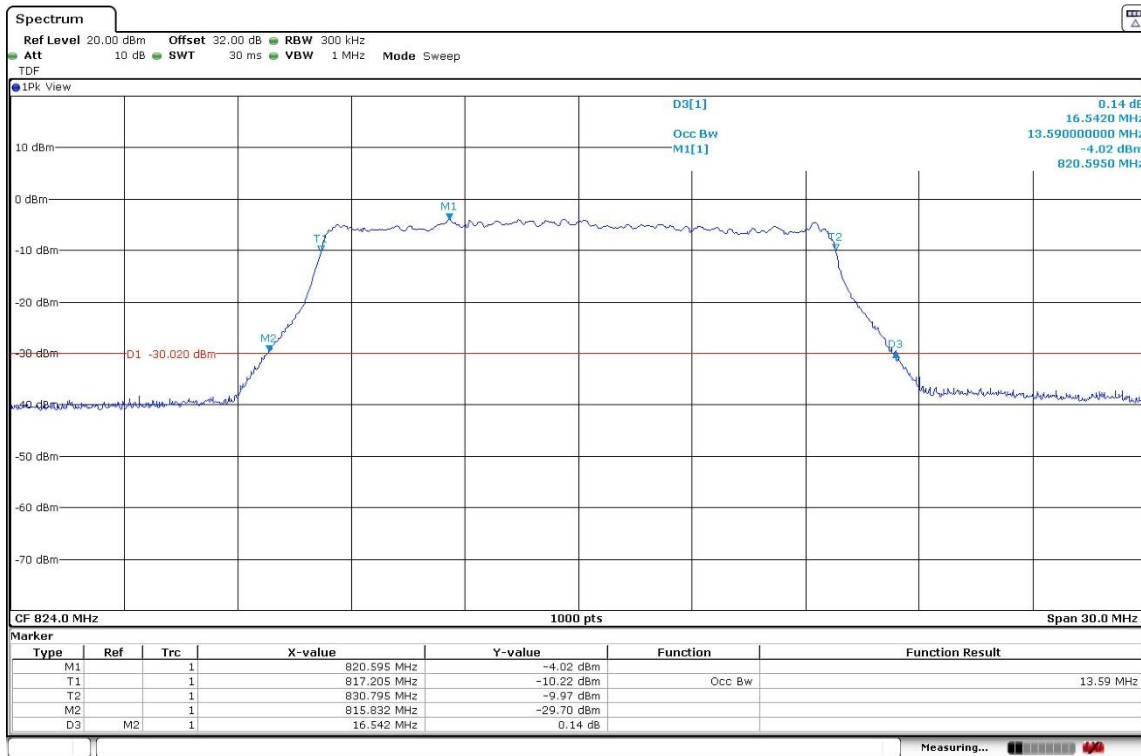
	Single Channel
99% Occupied Bandwidth (MHz)	13.590000
-26 dBc Bandwidth (MHz)	16.542000
Measurement uncertainty (kHz)	<±4.67

LTE Cat-4 Band 26. Cross-rule Channel 824 MHz. BW = 15 MHz. 16QAM. RB Size = All.

	Single Channel
99% Occupied Bandwidth (MHz)	16.422200
-26 dBc Bandwidth (MHz)	13.620000
Measurement uncertainty (kHz)	<±4.67

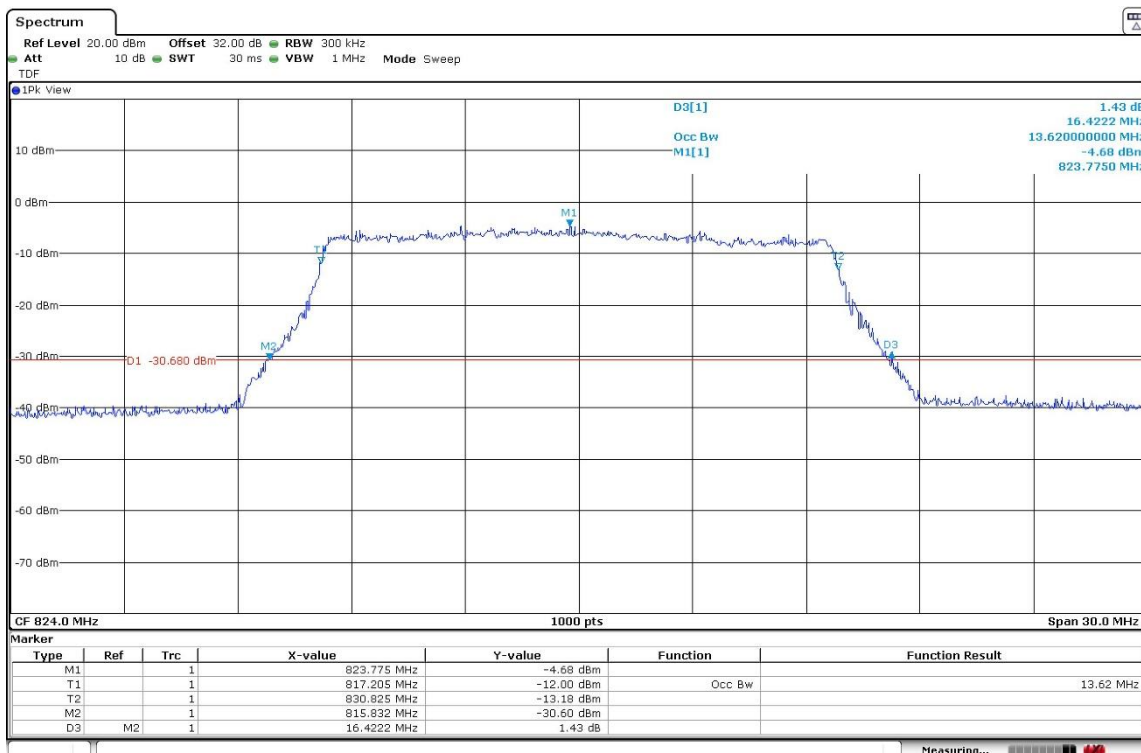
LTE Cat-4 Band 26. Cross-rule Channel 824 MHz. BW = 15 MHz. QPSK.

Cross-rule Channel 824 MHz:



LTE Cat-4 Band 26. Cross-rule Channel 824 MHz. BW = 15 MHz. 16QAM.

Cross-rule Channel 824 MHz:



## Spurious emissions at antenna terminals

### Limits

#### 1. LTE Cat-4 Band 14:

\* FCC § 90.543 (e) (2) (3) & (5):

Transmitters operating in 758-768 MHz and 788-798 MHz bands must meet the emission limitations in (e) of this section.

(e) For operations in the 758-768 MHz and the 788-798 MHz bands, the power of any emission outside the licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, in accordance with the following:

(1) On all frequencies between 769-775 MHz and 799-805 MHz, by a factor not less than  $76 + 10 \log (P)$  dB in a 6.25 kHz band segment, for base and fixed stations.

(2) On all frequencies between 769-775 MHz and 799-805 MHz, by a factor not less than  $65 + 10 \log (P)$  dB in a 6.25 kHz band segment, for mobile and portable stations.

(3) On any frequency between 775-788 MHz, above 805 MHz, and below 758 MHz, by at least  $43 + 10 \log (P)$  dB.

(4) Compliance with the provisions of paragraphs (e)(1) and (2) of this section is based on the use of measurement instrumentation such that the reading taken with any resolution bandwidth setting should be adjusted to indicate spectral energy in a 6.25 kHz segment.

(5) Compliance with the provisions of paragraph (e)(3) of this section is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. However, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of 30 kHz may be employed.

\* RSS-140 Clause 4.4:

The power of any unwanted emission outside the band 788-798 MHz shall be attenuated below the Transmitter output power P in dBW as follows, where p is the transmitter output power in watts:

- a. For any frequency between 769-775 MHz and 799-806 MHz:
  - i.  $76 + 10 \log (p)$ , dB in a 6.25 kHz band for fixed and base station equipment
  - ii.  $65 + 10 \log (p)$ , dB in a 6.25 kHz band for mobile and portable/hand-held equipment
- b. For any frequency between 775-788 MHz, above 806 MHz, and below 758 MHz:  $43 + 10 \log (p)$ , dB in a bandwidth of 100 kHz or greater. However, in the 100 kHz bands immediately outside and adjacent to the frequency bands 758-768 MHz and 788-798 MHz, a resolution bandwidth of 30 kHz may be employed.

#### 2. LTE Cat-4 Band 26:

\* FCC § 90.691:

(a) Out-of-band emission requirement shall apply only to the "outer" channels included in an EA license and to spectrum adjacent to interior channels used by incumbent licensees. The emission limits are as follows:

(1) For any frequency removed from the EA licensee's frequency block by up to and including 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least  $116 \log_{10}(f/6.1)$  decibels or  $50 + 10 \log_{10}(P)$  decibels or 80 decibels, whichever is the lesser attenuation, where f is the frequency removed from the center of the outer channel in the block in kilohertz and where f is greater than 12.5 kHz.

(2) For any frequency removed from the EA licensee's frequency block greater than 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least  $43 +$



$10\log_{10}(P)$  decibels or 80 decibels, whichever is the lesser attenuation, where  $f$  is the frequency removed from the center of the outer channel in the block in kilohertz and where  $f$  is greater than 37.5 kHz.

(b) When an emission outside of the authorized bandwidth causes harmful interference, the Commission may, at its discretion, require greater attenuation than specified in this section.

### **Method**

The EUT RF output connector was connected to a spectrum analyser and to the Universal Radio Communication tester R&S CMW500 (selecting maximum transmission power of the EUT and different modes of modulation) using a 50 Ohm attenuator and a power divider.

The spectrum was investigated from 9 kHz to 8 GHz for LTE Cat-4 Band 14; from 9 kHz to 10 GHz for LTE Cat-4 Band 26.

The reading of the spectrum analyser is corrected with the attenuation loss of connection between output terminal of EUT and input of the spectrum analyser.

The configuration of Resource Blocks and modulation which is the worst case for conducted power was used.

### Measurement Limit:

According to specification, the power of emissions shall be attenuated below the transmitter power ( $P$ ) by a factor not less  $65 + 10 \log (P)$  dB in a 6.25 kHz band segment.  $P$  in watts.

At  $P_o$  transmitting power, the specified minimum attenuation becomes  $65+10\log (P_o)$ , and the level in dBm relative  $P_o$  becomes:

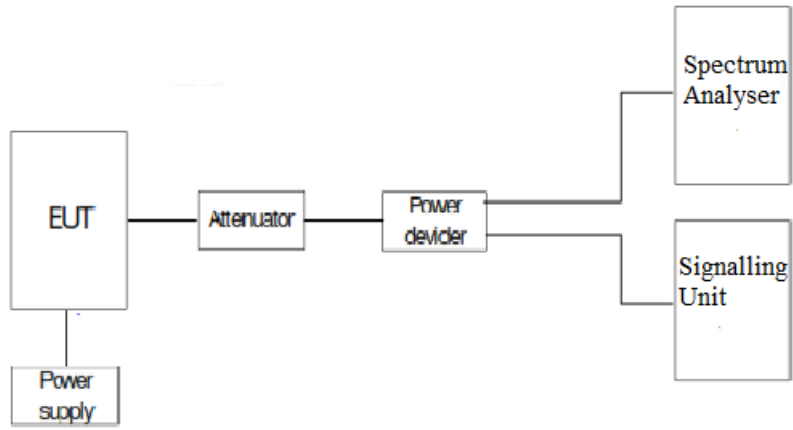
$$P_o \text{ (dBm)} - [65 + 10 \log (P_o \text{ in mwatts}) - 30] = - 35 \text{ dBm}$$

According to specification, the power of emissions shall be attenuated below the transmitter power ( $P$ ) by a factor of at least  $43 + 10 \log (P)$  dB.  $P$  in watts.

At  $P_o$  transmitting power, the specified minimum attenuation becomes  $43+10\log (P_o)$ , and the level in dBm relative  $P_o$  becomes:

$$P_o \text{ (dBm)} - [43 + 10 \log (P_o \text{ in mwatts}) - 30] = - 13 \text{ dBm}$$

### **Test Setup**



## Results

The next results are for the test performed on the worst case Bandwidth, Modulation, RB Size and RB Offset for each LTE band.

**LTE Cat-4 Band 14:** BW = 5 MHz. QPSK. RB Size=1. RB Offset=24.

### Frequency range 9 KHz - 8 GHz:

- Low Channel: No spurious frequencies detected at less than 20 dB below the limit.
- High Channel: Spurious frequencies detected at less than 20 dB below the limit:

Frequency (MHz)	Emission limitations conducted (dBm)
802.1047	-43.53

## Verdict

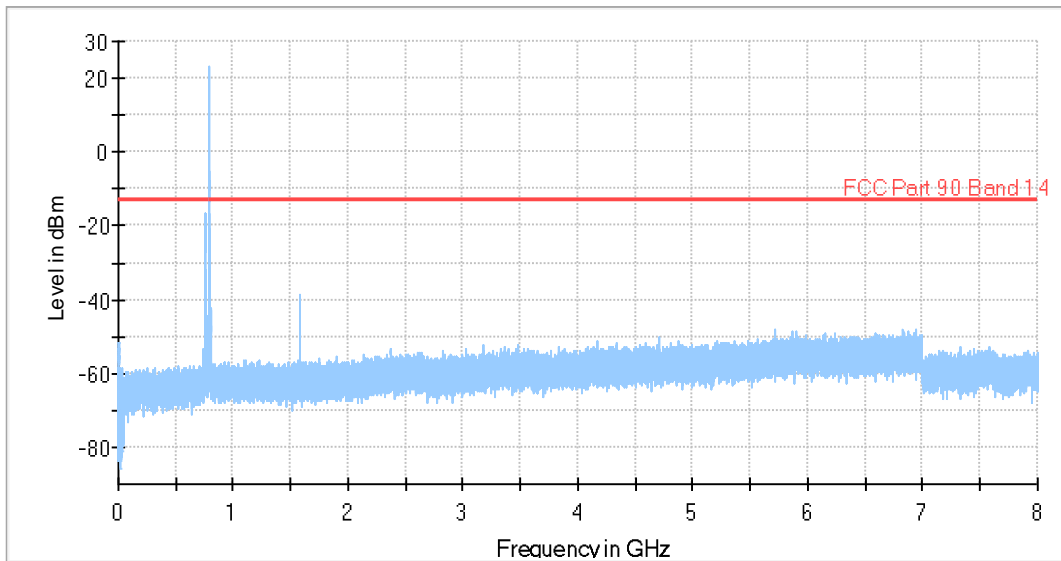
PASS

Subrange	Step Size	Detectors	Bandwidth	Sweep Time	Preamp
Receiver: [FSV 40]					
9 kHz - 150 kHz	14.1 Hz	PK+	300 Hz	Coupled	0 dB
150 kHz - 30 MHz	932.812 Hz	PK+	10 kHz	Coupled	0 dB
30 MHz - 1 GHz	30.312 kHz	PK+	100 kHz	Coupled	0 dB
1 GHz - 10 GHz	281.25 kHz	PK+	1 MHz	Coupled	0 dB

**LTE Cat-4 Band 14:** BW = 5 MHz. QPSK. RB Size=1. RB Offset=24.

Low Channel:

Full Spectrum



— Preview Result 1-PK+    — FCC Part 90 Band 14    ◆ Final\_Result PK+

The peak above the limit is the carrier frequency.

